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PROCEEDINGS

OF

THE CHEMICAL SOCIETY.

Vol. XII. Nos. 159—172.

JANUARY—DECEMBER, 1896.

EDITED BY THE SECRETARIES.

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DATES OF ISSUE OF THE MONTHLY NUMBERS OF THE
JOURNAL OF THE CHEMICAL SOCIETY TO FELLOWS.

January number was issued.....	8th January.
February ,,	8th February.
March ,,	9th March.
April ,,	14th April.
May ,,	15th May.
June ,,	22nd June.
July ,,	27th July.
August ,,	17th August.
September ,,	3rd September.
October ,,	9th October.
November ,,	6th November.
December ,,	30th December.

LIST OF GRANTS MADE FROM THE RESEARCH FUND DURING THE YEAR.

£6 10s. to Dr. E. P. Perman to carry on investigations on the nature of various solutions.

£35 to Mr. A. E. Tutton. Supplementary grant to cover cost of crystal dilatometer.

£10 to Dr. T. H. Easterfield for the furtherance of work now in progress upon the chemistry of Indian hemp.

£12 to Dr. J. J. Dobbie for the purchase of alkaloïds from *Corydalis cava*.

£10 to Dr. J. Walker to continue investigations of the products obtained in the electrolysis of organic salts.

£30 to Dr. D. H. Jackson for an investigation of the action of alcohols of the fatty series on various acetyl derivatives from different types of organic compounds.

£25 to Dr. A. W. Crossley for an investigation of the action of fused alkalis on camphoric acid, and for the perfecting of a method for the determination of the constitution of that acid and the compounds formed in the reaction.

£5 to Dr. H. W. Hake to carry on researches on the absorption of moisture by deliquescent salts.

£10 to Dr. W. T. Lawrence for the synthesis of trimethylglutaric acid and camphoronic acid.

£10 to Mr. W. H. Bentley for the synthesis of certain acids allied to camphoronic acid.

£15 to Dr. J. J. Sudborough for researches on stilbene derivatives.

£20 to Messrs. J. J. Hummel and A. G. Perkin to continue investigations on natural colouring matters.

£6 to Dr. F. D. Chattaway to study the formation of thionurea in the preparation of carbon oxysulphide.

£10 to Mr. W. H. Barker for a research on carbostyryl.

£15 to Mr. W. A. Bone for preparing tetracarboxylic acids, and to complete experiments on the decomposition of hydrocarbons at the temperature of the electric arc.

£20 to Mr. C. F. Cross for materials for an investigation of furfural-yielding carbohydrates.

£5 to Mr. R. E. Doran to continue work on the action of lead thiocyanate on the chlorocarbides.

£10 to Dr. J. H. Wigner to synthesise one of certain acids suggested allied to camphoric acid.

LIST OF FELLOWS ELECTED DURING 1896.

Name.	Proposed.	Elected.
Addie, Robert	April 23rd	June 18th.
Allan, John	December 5th, 1895 .	February 20th.
Aykroyd, Henry Edward	November 5th	December 3rd.
Ballingall, William	" "	" "
Barker, William Henry, B.Sc.	December 19th, 1895	February 20th.
Bathurst, Charles, junior, B.A.	November 5th	December 3rd.
Bauerfec, Gopal Chandra	" 19th	" "
Bay, Lauritz Hansen	" 5th	" "
Bentley, William Henry, B.Sc.	January 16th	February 20th.
Blood, Maurice, B.A.	December 19th, 1895	" "
Blyde, J. E. A.	November 21st, 1895.	" "
Bowley, Joseph John	January 16th	" "
Bowman, Herbert Lister, B.A.	December 5th, 1895	" "
Bray, Daniel	January 16th	" "
Browne, Charles Edward	November 5th	December 3rd.
Burbridge, James Kerry	December 5th, 1895	February 20th.
Caley, John	April 23rd	June 18th.
Candy, Hugh C. H., B.A., B.Sc.	January 16th	February 20th.
Cobb, Walter William, M.A.	June 4th	December 3rd.
Craig, James, M.A., B.Sc.	December 19th, 1895	February 20th.
Crossman, Charles Matthew, B.Sc.	April 23rd	June 18th.
Cross, George Harold, B.Sc.	November 5th	December 3rd.
Davies, Llewellyn John	May 7th	June 18th.
Dixon, Frank	December 5th, 1895 .	February 20th.
Duncan, William	November 5th	December 3rd.
Durant, Henry Thomas	" "	" "
Eiloart, Arnold, Ph.D.	" 21st, 1895.	February 20th.
Elliott, Walter John, M.A.	" 5th	December 3rd.
Ewan, Thomas, B.Sc., Ph.D.	January 16th	February 20th.
Ewen, Erick David	November 19th	December 3rd.
Fisher, Ernest Hunter	February 6th	May 7th.
Fleet, John Thomas	November 5th	December 3rd.
Fuller, Charles James Pemeller	December 19th, 1895	February 20th.
George, George	November 5th	December 3rd.
Goldstand, Leon Felix	May 21st	June 18th.
Goodwin, William	March 19th	May 7th.
Grice, Walter Thomas	November 21st, 1895	February 20th.
Hanger, Ralph Hamilton	April 23rd	June 18th.
Harrington, William	January 16th	February 20th.
Harris, Frederick William	May 7th	June 18th.
Hawkins, Edgar, M.D., M.S., M.A.	March 19th	May 7th.
Helps, James William	November 21st, 1895	February 20th.
Hill, Arthur Croft, B.A.	" "	December 3rd.
Hill, Charles Alexander	" "	" "
Hill, Ernest George, B.A.	May 21st	June 18th.

Name.	Proposed.	Elected.
Hinchley, John William	November 5th	December 3rd.
Howard, Albert.....	January 16th.....	February 20th.
Hughes, J. Arthur.....	May 21st	June 18th.
Jeffers, Ernest Haynes.....	January 16th.....	February 20th.
Jenkins, John Percival.....	March 5th	May 7th.
Johnstone, James, F.I.C.....	January 16th	February 20th.
Jones, Robert Haslewood.....	March 19th	May 7th.
Kennicott, Cass L.	November 21st, 1895	February 20th.
Knight, John Burnett	May 7th	June 18th.
Law, Herbert E.	" 21st	" "
Lawrence, William Trevor, B.A., Ph.D.	November 5th	December 3rd.
Lethbridge, William Arthur Finch	April 23rd	June 18th.
Lidgey, Cecil Rudolf	" "	" "
Littlefield, Robert Dexter	November 5th	December 3rd.
Lloyd, Thomas Henry	" "	" "
Lockwood, Thomas William.....	" "	" "
Macadam, Herbert Edwin.....	February 20th.....	May 7th.
Manners, Hugh, M.A., B.Sc.	June 18th.....	December 3rd.
Marks, Edward Seaborn.....	November 5th	" "
Marshall, Percy Sykes	May 7th	June 18th.
Mathieson, Lawrence W.	November 21st, 1895	February 20th.
Mayfield, Arthur Stanley.....	" 5th	December 3rd.
McConnell, William, junr.	April 23rd	June 18th.
McCrae, John, junr., Ph.D.	March 19th	May 7th.
Meggitt, Loxley.....	May 7th	June 18th.
Merrett, William Henry	February 6th	May 7th.
Miller, William M.	November 5th	December 3rd.
Mitra, Asutosh, Rai Buhadur.....	May 21st.....	June 18th.
Moore, Landon Clarence	November 5th	December 3rd.
Morrison, Joseph Edward	December 5th, 1895..	February 20th.
Moss, Francis Ambrose	November 5th	December 3rd.
Moss, Herbert William	" "	" "
Mothe, Joseph Terrence de la.....	" "	" "
Muir, James Stanley, B.Sc.....	April 23rd	June 18th.
Muter, Alexander Henry Mitchell.....	November 5th	December 3rd.
Overton, James Hadden	April 23rd	June 18th.
Page, Hastings Montague	" "	" "
Patterson, Joseph W.	February 6th	May 7th.
Payne, Arthur.....	April 23rd	June 18th.
Pearsall, William Harrison	November 5th	December 3rd.
Pechman, Hans (Freiherr) von	February 6th	May 7th.
Pilley, Thomas William.....	March 19th	" "
Pollitt, Robert Barnabas	" "	" "
Potts, Henry William	November 5th	December 3rd.
Power, Frederick Belding, Ph.D.	" "	" "
Proude, James	February 6th	May 7th.
Reissman, Charles H., B.A., B.Sc.....	February 20th.....	" "
Robinson, Henry Fishwick, B.Sc.	" 6th	" "
Rosenblum, Sigmund Georgjewitsch....	May 7th	June 18th.
Rosenheim, Otto, Ph.D.	March 19th	May 7th.

Name.	Proposed.	Elected.
Ross, Raymond St. George	March 5th	May 7th.
Rostron, Harold, B.Sc.	December 5th, 1895..	February 20th.
Russell, William	November 5th	December 3rd.
Rutter, Thomas Francis, B.Sc.	„ 21st, 1895.	February 20th.
Sage, Charles Edward	January 16th.....	„ „
Salt, Arthur Phillip.....	November 21st, 1895.	„ „
Saville, Arthur Edwin.....	June 4th.....	December 3rd.
Scotland, Peter B.....	December 5th, 1895..	February 20th.
Seabrooke, Herbert Cecil.....	November 5th	December 3rd.
Severn, Walter Dalrymple.....	March 19th	May 7th.
Shimomura, Kotaro	June 4th.....	December 3rd.
Simpson, Aitken Migget.....	December 5th, 1895 .	February 20th.
Sircar, Amrita Lal	November 21st, 1895.	„ „
Skelton, Samuel Thomas.....	May 21st.....	June 18th.
Smith, George Egerton Scot.....	April 23rd	„ „
Smith, Henry George	December 5th, 1895 .	February 20th.
Sodeau, William Horace, B.Sc.	November 5th	December 3rd.
Stead, John Christopher	March 19th	May 7th.
Stewart, Douglas Stuart Spens, B.Sc....	May 7th	June 18th.
Thompson, Charles, B.Sc.	November 5th	December 3rd
Tuckett, James Edward Shum, M.A....	February 20th	May 7th.
Turner, Benjamin Bernard, B.Sc.	November 21st, 1895	February 20th.
Walker, William Henry	„ 5th	December 3rd.
Watson, William, M.A.....	„ „	„ „
Wheelwright, Edwin Whitfield	„ „	„ „
Whimster, John Inctus	June 4th.....	„ „
Whitehead, James	May 7th	June 18th.
Wigner, John Harrison, Ph.D.....	November 5th	December 3rd.
Wilcox, Alfred James	June 4th.....	„ „
Wills, Edward Chaning, M.A.	March 19th	May 7th.
Wolfenden, John Hy., B.Sc.....	February 6th	„ „

FELLOWS DECEASED

Name.	Elected.	Died.
Anderson, J. M. T.	February 6th, 1890.....	October , 1896.
Cave, H.	March 20th, 1894	, 1895.
Curragh, John.....	February 21st, 1889	
Hall, Capt. Marshall....	May 3rd, 1866	March 14th, 1896.
Harley, George.....	March 2nd, 1857	October 27th, 1896.
Hart, James.....	March 15th, 1888.....	April , 1896.
Hughes, John.....	May 17th, 1888	May , 1896.
Kekulé, A.....	June 19th, 1862.....	July 13th, 1896.
Lapraik, William	June 21st, 1877	October 5th, 1896.
Mackay, J. B. L.....	December 2nd, 1886 ...	March 11th, 1894.
Mason, A. H.....	March 2nd, 1871	November 2nd, 1896.
Morgan, William.....	April 3rd, 1873	
Mott, H. A.....	December 2nd, 1880	
Mueller, Baron Ferd. von	June 19th, 1884.....	October 9th, 1896.
Palmer, W. J.....	November 19th, 1868	August 26th, 1896.
Prestwich, Sir Joseph....	May 16th, 1861	June 23rd, 1896.
Rawlins, Edward	April 21st, 1887.....	November 22nd, 1896.
Schacht, G. F.....	February 6th, 1873	December 26th, 1896.
Scorgie, James.....	June 18th, 1863	, 1895.
Schimidzu, T.	December 16th, 1886	May 13th, 1896.
Smith, T. J.....	April 7th, 1856	October 3rd, 1896.
Walenn, W. H.....	February 15th, 1866.....	September 20th, 1896.
Weaver, Richard.....	June 6th, 1872.....	May , 1896.
Winstone, A. B.	November 19th, 1885	, 1895.
Wood, John.....	December 7th, 1876.....	September 17th, 1895.
Wood, W. H.	February 19th, 1880	May 19th, 1896.

TITLES OF PAPERS COMMUNICATED TO THE SOCIETY
DURING 1896.

	Page in Pro- ceedings.	Page in Trans- actions.
<i>January 16th.</i>		
1. The acetylene theory of luminosity. By Vivian B. Lewes.....	1	226
2. The action of sodium alcoholate on certain aromatic amides. By J. B. Cohen, Ph.D., and W. H. Archdeacon, B.Sc.....	8	91
3. Note on the electrolytic conductivity of formanilide and thioformanilide. By Thomas Ewan, Ph.D., B.Sc.	8	96
4. The action of sugar on ammoniacal silver nitrate. By J. Henderson, B.Sc.....	9	145
5. Solution of diffusion of certain metals in mercury. By W. J. Humphreys	9	243
6. On some of the ethereal salts of active and inactive monobenzoyl-, dibenzoyl-, diphenylacetyl-, and dipropionylglyceric acids. By Percy Frankland, Ph.D., F.R.S., and John MacGregor, M.A.....	9	104
7. On the rotation of optically active compounds in organic solvents. By Percy Frankland, Ph.D., F.R.S., and R. H. Pickard, B.Sc.....	11	123
8. Note on the action of hydrogen chloride on ethyl alcohol. By J. C. Cain, B.Sc., Ph.D.....	12	—
9. Transformation of the alkylammonium cyanates into the corresponding urcas. By J. Walker and J. R. Appleyard	12	193
10. On certain phenylthiocarbamates. By H. Lloyd Snape, D.Sc., Ph.D.	12	98
11. The available potash in soils. By T. B. Wood, M.A....	13	287
<i>February 6th.</i>		
12. The molecular weight and formula of phosphoric anhydride, and of metaphosphoric acid. By W. A. Tilden and R. E. Barnett	30	154
13. Lead tetracetate and the plumbic salts. By A. Hutchinson, M.A., Ph.D., and W. Pollard, B.A., Ph.D.	30	212
14. An improved method of determining urea by the hypobromite process. By Alfred H. Allen	31	—
15. Preliminary note on the absorption of moisture by deliquescent salts. By H. Wilson Hake, Ph.D.....	33	—
16. Some derivatives of γ -phenoxyethylmalonic acid and of γ -phenoxyethylacetic acid. By W. H. Bentley, E. Haworth, and W. H. Perkin, junr.	35	161

	Page in Pro- ceedings.	Page in Trans- actions.
17. Note on the preparation of glycol. By E. Haworth and W. H. Perkin, junr.....	37	175
18. Luteolin. Part I. By A. G. Perkin	37	206
19. An examination of the products obtained by the dry distillation of bran with lime. By W. F. Laycock, Ph.D.....	38	—
20. Constitution of glycocine. By Jōji Sakurai.....	38	—

February 20th.

21. The origin of colour. No. XI. The yellow colour of 2 : 3-hydroxynaphthoic acid. By Henry E. Arm- strong.....	42	—
22. Note on etherification. By Henry E. Armstrong.....	43	—
23. The relation of pinene to citrene. By Henry E. Arm- strong.....	44	—
24. The conditions involved in the occurrence of inversion in the case of asymmetric (optically active) com- pounds. By Henry E. Armstrong.....	45	—
25. The production of naphthalene and of isoquinoline derivatives from dehydracetic acids. By J. Norman Collie, Ph.D., and N. T. M. Wilshire, M.Sc.	47	293
26. Note on a difficulty encountered in the determination of nitrogen by the absolute method. By Wyndham R. Dunstan, F.R.S., and F. H. Carr.....	48	—
27. Mixed diazoamides containing an orthonitro-group By Raphael Meldola, F.R.S., and Frederick William Streatfeild, F.I.C.....	49	—
28. Allyl- <i>p</i> -dinitrodiazoamidobenzene: a study of the rela- tions between melting point and constitution. By Raphael Meldola, F.R.S., and Frederick William Streatfeild, F.I.C.....	51	—

March 5th.

29. The explosion of cyanogen. By H. B. Dixon, M.A., F.R.S., E. H. Strange, B.Sc., and E. Graham, B.Sc.	53	759
30. On the mode of formation of carbon dioxide in the burning of carbon compounds. By H. B. Dixon, M.A., F.R.S.....	55	774
31. On the explosion of chlorine peroxide. By H. B. Dixon, M.A., F.R.S., and J. A. Harker, D.Sc.....	57	789
32. Note on the use of certain phosphorescent substances in rendering X-rays visible. By Herbert Jackson..	57	—
33. The union of carbon and hydrogen. By William A. Bone, M.Sc., Ph.D., and David S. Jerdan, M.A., B.Sc.....	60	—
34. Note on the $\alpha\alpha$ -dimethylglutaric acids. By William A. Bone, M.Sc., Ph.D., and W. H. Perkin, junr., F.R.S.....	63	268
35. The symmetrical dimethylsuccinic acids. By William A. Bone, M.Sc., Ph.D., and W. H. Perkin, junr., F.R.S.	63	253

XI

	Page in Pro- ceedings.	Page in Trans- actions.
35. The cis- and trans-methylisopropylsuccinic acids. By William Henry Bentley, William Henry Perkin, junr., and Jocelyn F. Thorpe.....	64	270
<i>March 19th.</i>		
37. The constitution of a new organic acid resulting from the oxidation of tartaric acid. By Henry J. Horstman Fenton, M.A.	67	516
38. The volume and optical relationships of the potassium, rubidium, and caesium salts of the monoclinic series, $R_2M(SO_4)_2 \cdot 6H_2O$. By A. E. Tutton, Assoc. R.C.S.	68	344
39. Comparison of the results of the investigations of the simple and double sulphates containing potassium, rubidium, and caesium. By A. E. Tutton, Assoc. R.C.S.	71	495
40. The bearing of the results of the investigations of the simple and double sulphates containing potassium, rubidium, and caesium upon the nature of the structural unit. By A. E. Tutton, Assoc. R.C.S.	71	507
41. The hydriodides of hydroxylamine. By Wyndham R. Dunstan, F.R.S., and Ernest Goulding.....	72	839
42. An analysis of the water from the dropping well at Knaresborough, in Yorkshire. By R. A. Burrell ..	73	536
43. Contributions to the knowledge of ethylic acetoacetate. Part I. Acetonilmalic acid. By S. Ruhemann, Ph.D., M.A., and E. A. Tyler ...	73	520
44. The action of lead thiocyanate on the chlorocarbonic esters. Part I. Carboxyethylthiocarbimide and its derivatives. By Robert E. Doran	74	324
45. An auxiliary assay balance. By Robert Law, F.I.C. .	75	526
46. Charas: the resin of Indian hemp. By T. B. Wood, M.A., W. T. N. Spivey, M.A., B.Sc., and T. H. Easterfield, M.A., Ph.D.	76	539
47. Note on the decomposition of α -chloronitrocarnphor. By Arthur Lapworth, D.Sc.	76	322
48. π -Bromocarnphor. By C. Revis, Assoc. C. G. Inst., and F. Stanley Kipping, Ph.D., D.Sc.	77	—
49. Oxidation products of α -bromocarnphorsulphonic acid. By Arthur Lapworth, D.Sc., and F. Stanley Kipping, Ph.D., D.Sc.	77	304
50. On the xylic and xylidinic acids. By William H. Bentley and William Henry Perkin, junr.....	79	—
<i>April 23rd.</i>		
51. The constitution of the cereal celluloses. By C. F. Cross, E. J. Bevan, and Cland Smith	95	804
52. On a new compound of cobalt, and a rapid method of detecting cobalt in presence of nickel. By R. G. Durrant	96	—

	Page in Pro- ceedings.	Page in Trans- actions.
53. Etheral salts of optically active malic and lactic acids. By Thomas Purdie, F.R.S., and Sidney Williamson, Ph.D.	96	818
54. Metadichlorobenzene. By Frederick D. Chattaway, D.Sc., and R. C. T. Evans	97	848
55. On the temperature of certain flames. By W. N. Hartley, F.R.S.	98	844
56. The determination of the composition of a white sou by a method of spectrum analysis. By W. N. Hartley, F.R.S.	98	842
57. Halogen additive products of substituted thiosinn- amines. By Augustus E. Dixon, M.D.	99	851
58. Acidic thiocarbamides, thioureas, and ureas. By Augustus E. Dixon, M.D.	100	855
59. Apparatus for the detection of boric acid. By W. M. Doherty	101	—
<i>May 7th.</i>		
60. Carbon dioxide, its volumetric determination. By W. H. Symons and F. R. Stephens	103	869
61. On certain views concerning the condition of the dis- solved substances in solutions of sodium sulphate. By R. F. D'Arcy, M.A.	104	993
62. Luteolin. II. By A. G. Perkin	105	799
63. Morin. I. By Hermann Bablich, Ph.D., and Arthur George Perkin.	106	792
64. Synthesis of pentacarbon rings. Part I. Anhydr- acetone benzil and its homologues. By Francis R. Japp, F.R.S., and G. Druce Lander, B.Sc.	107	123*
65. Synthesis of pentacarbon rings. Part II. Condensa- tion of benzil with acetonedicarboxylic acid. By Francis R. Japp, F.R.S., and G. Druce Lander, B.Sc.	109	129*
66. Reduction of desyleneacetic acid and the constitution of Zinin's pyroamaric acid. By Francis R. Japp, F.R.S., and G. Druce Lander, B.Sc.	109	151*
67. Electrolysis of potassium allo-ethylic camphorate. II. By James Walker, Ph.D., D.Sc., and James Hender- son, B.Sc.	110	748
68. Fluorene and acetrnaphthene. By W. R. Hodgkinson	110	—
<i>May 21st.</i>		
69. The diphenylbenzenes. I. Metadiphenylbenzene. By Frederick D. Chattaway, M.A., and R. C. T. Evans	113	980
70. Derivatives of camphoric acid. Part I. By F. Stanley Kipping, Ph.D., D.Sc.	114	913
71. On some substances which exhibit rotatory power both in the liquid and crystalline states. By William Jackson Pope.	116	971

	Page in Pro- ceedings.	Page in Trans- actions.
72. Dimethoxydiphenylmethane and some of its homo- logues. By John E. Mackenzie, Ph.D., B.Sc.	117	985
<i>June 4th.</i>		
73. On magnetic rotatory power, especially of aromatic compounds. By W. H. Perkin, LL.D., Ph.D., F.R.S.	122	1025
74. Mononitroguaiacol. By Raphael Meldola, F.R.S.	125	—
<i>June 18th.</i>		
75. The action of bromine on pinene with reference to the question of its constitution. By W. A. Tilden, D.Sc., F.R.S.	137	1059
76. Preliminary note on some products from pinene tetra- bromide. By W. A. Tilden, D.Sc., F.R.S., and A. Nicholls	138	—
77. An apparatus for showing experiments with ozone. By G. S. Newth	139	1298
78. Note on sanatal and some of its derivatives. By Alfred C. Chapman, F.I.C., and Herbert E. Burgess	140	—
79. Second note on the liberation of chlorine during the heating of a mixture of potassic chlorate and man- ganic peroxide. By Herbert McLeod, F.R.S.	141	1015
80. Polymorphism as an explanation of the thermochemi- cal peculiarities of chloral and bromal hydrates. By William Jackson Pope	142	—
81. Explosion and detection of acetylene in the air. By Frank Clowes, D.Sc.	143	—
82. On the occurrence of quercetin in the outer skins of the bulb of the onion (<i>Allium cepa</i>). By A. G. Perkin and J. J. Hummel.	144	1295
83. On the colouring matter contained in the bark of <i>Myrica nagi</i> . Part I. By A. G. Perkin and J. J. Hummel.	145	1287
84. Preliminary note on a new base derived from camphor- oxime. By Martin O. Forster, Ph.D., A.R.C.S.	145	—
85. The rotation of aspartic acid. By B. M. C. Marshall..	146	1022
86. Synthesis of pentacarbon rings. Part III. Condensa- tion of benzil with lævulic acid. By Francis R. Japp, F.R.S., and T. S. Murray, D.Sc.	146	144*
87. Absorption of dilute acids by silk. By James Walker and James R. Appleyard.	147	1334
88. Position-isomerism and optical activity; the methylic and ethylic salts of ortho-, meta-, and para-ditoluyl- tartaric acid. By Percy Frankland, Ph.D., F.R.S., and Frederick Malcolm Wharton, F.I.C.	148	1300
89. Double sulphides of gold and other metals, or the action at a red heat of sulphur upon gold when alloyed with other metals. By J. S. MacLurin, B.Sc., University College, Auckland, New Zealand	149	1269

	Page in Pro- ceedings.	Page in Trans- actions.
90. The relative weights of gold and silver dissolved by potassium cyanide solutions from alloys of these metals. By J. S. Maclaurin, B.Sc.	149	1276
91. The three chlorobenzeneazosalicylic acids. By J. T. Hewitt, M.A., D.Sc., Ph.D., and H. E. Stephenson..	149	1257
92. Condensation of chloral with resorcinol. By J. T. Hewitt, M.A., D.Sc., Ph.D., and F. G. Pope	150	1265
93. The atomic weight of Japanese tellurium. By Masumi Chikashigé, B.Sc., Imperial University, Japan	151	881
94. Derivatives of camphenesulphonic acids. By Arthur Lapworth and Frederic Stanley Kipping	152	—
95. Iodoso- and iodoxy-benzaldehydes. By Victor Meyer and T. S. Patterson	153	1002
96. α -Isopropylglutaric acid. By W. H. Perkin, junr., F.R.S.	153	—
97. The action of ethylic β -iodopropionate on the sodium derivative of ethylic isopropylmalonate. By J. Z. Heinke and W. H. Perkin, junr., F.R.S.	155	1506
98. The condensation of halogen derivatives of fatty ethereal salts with ketones and ketonic acids. By W. H. Perkin, junr., F.R.S., and J. F. Thorpe.	155	—
99. The electrolysis of the salts of monhydroxy acids. By J. Wallace Walker, M.A., Ph.D.	157	1278
100. The action of formic aldehyde on phenylhydrazine and on some hydrazones. By J. Wallace Walker, M.A., Ph.D.	157	1280
101. The colouring matter of Sicilian sumach, <i>Rhus coriaria</i> . By A. G. Perkin and George Young Allen	157	1299
102. The colouring matter of <i>Querbracho Colorado</i> . By A. G. Perkin and Oswald Gunnell.	158	1303
103. On atisine, the alkaloïd of <i>Aconitum heterophyllum</i> . By H. A. D. Jowett, D.Sc.	158	1518
104. The action of methyl alcohol on aconitine. Formation of methyl benzaconine. By Wyndham R. Dunstan, F.R.S., Thomas Tickle, and D. H. Jackson, Ph.D.	159	—
105. The chemical inactivity of Röntgen rays. By H. B. Dixon and H. Brereton Baker	160	1303
106. Colloidal chromsulphuric acid. By H. T. Calvert and T. Ewan	160	—

Papers received during vacation and published in Transactions.

107. Contributions to the chemistry of phenol derivatives. By R. Meldola, F.R.S., G. H. Woolcott, and E. Wray ..	163	1321
108. Action of light on amyl alcohol. By A. Richardson, Ph.D., and Emily C. Fortey, B.Sc.	164	—
109. Note on the action of light on ether. By A. Richardson, Ph.D., and Emily C. Fortey, B.Sc.	165	—

	Page in Pro- ceedings.	Page in Trans- actions.
110. The constitution of lapachol and its derivatives. Part III. The structure of the amylene chain. By Samuel C. Hooker	166	1355
111. Lomatiol. By Samuel C. Hooker	166	1381
112. Contributions to the knowledge of the β -ketonic acids. Part II. By Siegfried Ruhemann, Ph.D., M.A., and C. G. L. Wolf, B.A., M.D.	166	1383
113. Formation of pyrazolone derivatives from chloro-fumaric acid. By Siegfried Ruhemann, Ph.D., M.A.	166	1397
114. Studies of the terpenes and allied compounds. Note on ketopinic acid—a product of the oxidation of the solid hydrochloride (chlorocamphydrene) prepared from pinene. By Henry E. Armstrong	167	1397
115. Acid compounds of natural yellow colouring matters. Part II. By A. G. Perkin	167	1439
116. Studies on citrazinic acid. Part IV. By W. J. Sell, M.A.	168	1447
117. The action of certain acidic oxides on salts of hydroxy-acids. III. By G. G. Henderson, D.Sc., M.A., and John M. Barr	168	1457
118. Note on γ -acetobutyric acid. By W. H. Bentley and W. H. Perkin, junr.	169	1510
119. Some derivatives of propionic acid, of acrylic acid, and of glutaric acid. By W. H. Perkin, junr.	170	1457
120. On the action of chloroform and potash on metamido-benzoic acid. By W. J. Elliott, M.A.	171	1513
<i>November 5th.</i>		
121. The constitution of the so-called nitrogen iodide. By F. D. Chattaway, M.A.	172	1572
122. The carbohydrates of barley-straw. By C. F. Cross, E. J. Bevan, and C. Smith	174	1604
123. The direct union of carbon and hydrogen. By William A. Bone, and David S. Jerdan	175	41*
124. The explosion of acetylene with less than its own volume of oxygen. By William A. Bone and John C. Cain	176	26*
125. The refraction constants of crystalline salts. By William Jackson Pope	177	1530
126. Compounds of metallic hydroxides with iodine. By Theodore Rettie, B.Sc.	178	—
127. Economical preparation of hydroxylamine sulphate. By E. Divers, M.D., F.R.S., and T. Haga, D.Sc.	178	1665
128. The reduction of nitrososulphates. By E. Divers, M.D., F.R.S., and T. Haga, D.Sc.	179	1610
129. Imidosulphonates. Part II. By E. Divers, M.D., F.R.S., and T. Haga, D.Sc.	179	1620
130. Amidosulphonic acid. By E. Divers, M.D., F.R.S., and T. Haga, D.Sc.	180	1634
131. Molecular conductivity of amido-sulphonic acid. By J. Sakurai	181	1654

	Page in Pro- ceedings.	Page in Transac- tions.
132. The physiological action of amidosulphonic acid. By Oscar Loew, Ph.D.	182	1662
133. How mercurous and mercuric salts change into each other. By S. Hada, B.Sc.	182	1667
134. The effect of heat on aqueous solutions of chrome alum. By Margaret D. Dougal.	183	1526
135. On the hydrolysis of ethylic dicarboxylglutaconate. By H. W. Bolam, B.Sc., Ph.D.	184	—
136. The periodic law. By R. M. Deeley.	185	—
137. The colouring matters occurring in various British plants. Part I. By A. G. Perkin and J. J. Hummel.	185	1566
133. Position-isomerism and optical activity; the comparative rotatory powers of the dibenzoyl and ditoluyltartrates. By Percy Frankland, Ph.D., F.R.S., and Frederick Malcolm Wharton, A.I.C.	186	1583
139. Researches on the terpenes. VII. Halogen derivatives of camphor. By J. E. Marsh and J. H. Gardner.	187	—
140. Derivatives of camphenesulphonic acids. By Arthur Lapworth, D.Sc., and Frederick Stanley Kipping, Ph.D., D.Sc.	188	1546
141. Preparation of dimethylketohexamethylene and experiments on the synthesis of dimethylhexamethenylmalonic acid. By F. Stanley Kipping, Ph.D., D.Sc., and W. B. Edwards.	188	—
142. Sulphocamphylic acid, with remarks on the constitution of camphoric acid and of camphoronic acid. By William Henry Perkin, junr.	189	—
143. On Pettenkofer's method for determining carbonic anhydride in air. By Professor Letts, D.Sc., Ph.D., and R. F. Blake, F.I.C.	192	—
<i>November 19th.</i>		
144. Sulphocamphoric acid and derivatives of camphorsulphonic acid. By Arthur Lapworth, D.Sc., and Frederic Stanley Kipping, Ph.D., D.Sc.	215	1*
145. A compound of camphoric acid and acetone. By William Jackson Pope.	217	1696
146. Mercury hyponitrites. By P. C. Rây, D.Sc.	217	—
147. The nitrites of mercury and the conditions under which they are formed. By P. C. Rây, D.Sc.	217	—
148. The interaction of mercurous nitrite and the alkyl iodides. By P. C. Rây, D.Sc.	218	—
149. Crystallography of the monohydrated mercurous nitrite. By T. H. Holland, F.G.S.	218	—
150. On the identity of dextrose from different sources; with special reference to the cupric oxide reducing power. By C. O'Sullivan, F.R.S., and A. L. Stern, D.Sc.	218	1691
151. Note on Mr. W. J. Humphreys' paper on the solution and diffusion of certain metals in mercury. By Professor Roberts-Austen, C.B., F.R.S.	219	—

	Page in Pro- ceedings.	Page in Transac- tions.
152. Solution and diffusion of certain metals and alloys in mercury. Part II. By W. J. Humphreys	220	1679
153. Note on the heat of formation of the silver amalgam, Ag_2Hg_3 . By Fannie T. Littleton	220	—
154. Preliminary note on the action of alkyl iodides on silver malate. By Thomas Purdie, F.R.S., and G. Druce Lander, B.Sc.	221	—
155. On certain thiocarbimides derived from complex fatty acids. By Augustus E. Dixon, M.D.	223	—
<i>December 3rd.</i>		
156. Constitution and colour. By Arthur G. Green.....	226	—
157. Derivatives of α -hydrindone. By C. Revis and F. Stanley Kipping, Ph.D., D.Sc.	229	238*
158. Notes on nitration. By Henry E. Armstrong	230	—
159. 3'-Bromo- β -naphthol. By Henry E. Armstrong and W. A. Davis	230	—
160. Derivatives of nitro- β -naphthols. By W. A. Davis ..	231	—
161. Morphotropic relations of β -naphthol derivatives. By W. A. Davis.....	233	—
162. Researches on tertiary benzenoid amines. II. By Clare de Brereton Evans, B.Sc.	234	—
163. On the circumstances which affect the ratio of solution of zinc in dilute acids, with especial reference to the influence of dissolved metallic salts. By John Ball, A.R.S.M.	235	—
164. The oxidation of ferrous sulphate by sea-water, and on the detection of gold in sea-water. By E. Sonstadt.....	236	—
<i>December 17th.</i>		
165. On the experimental methods employed in the examination of the products of starch hydrolysis by diastase. By Horace T. Brown, F.R.S., G. Harris Morris, Ph.D., and J. H. Millar.....	241	72*
166. On the specific rotation of maltose and of soluble starch. By Horace T. Brown, F.R.S., G. Harris Morris, Ph.D., and J. H. Millar.....	242	109*
167. On the relation of the specific rotatory and cupric-reducing powers of the products of starch-hydrolysis by diastase. By Horace T. Brown, F.R.S., G. Harris Morris, Ph.D., and J. H. Millar	243	115*
168. The action of hydrogen peroxide and other oxidising agents on cobaltous salts in presence of alkali bicarbonates. By R. G. Durrant, M.A.....	244	—
169. Electrical conductivity of diethylammonium chloride in aqueous alcohol. By James Walker, Ph.D., D.Sc., and F. J. Hambly, F.I.C.	246	61*

	Page in Pro- ceedings.	Page in Trans- actions
170. Formation of substituted oxytriazoles from phenyl-semicarbazide. By George Young, Ph.D., and Henry Annable.....	246	200*
171. α -Bromocamphorsulpholactone. By C. Reiss and F. Stanley Kipping, Ph.D., D.Sc.	247	—
172. Dimethylketohexamethylene. By F. Stanley Kipping, Ph.D., D.Sc.	247	—
173. The localisation of deliquescence in chloral hydrate crystals. By William Jackson Pope	249	—
174. Enantiomorphism. By William Jackson Pope and Frederic Stanley Kipping	249	—

* Papers printed in the Transactions for 1897 are distinguished by an asterisk after the page number. Where no reference is given to the Transactions, the paper has appeared only in the "Proceedings."

ERRATA.

Page. Line.

39 15 *for* "chloractic" *read* "chloracetic."

46 11 " "opheal" *read* "optical."

67 16 " "oxidadation" *read* "oxidation."

74 36 " "metoxylyl" *read* "metaxylyl."

110 32 " "my" *read* "the author's."

120 30 } " "Avogadro" *read* "Avogadro."

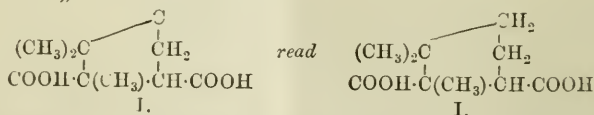
121 6 }

177, pars. 1—4 follow p. 175.

187 30 *seq.*, *for* "hyd ochlorate" *read* "hydrochloride."

191 14 *for* $C_9N_{14}O_3$ *read* $C_8H_{14}O_3$.

191 29 "



192 4 *for* " $\text{COOH} \cdot \text{CH}_2 \cdot \text{C}(\text{CH}_3)_2(\text{COOH}) \cdot \text{CH}_2 \cdot \text{COOH}$ " *read*
 $\text{COOH} \cdot \text{C}(\text{CH}_3)_2 \cdot \text{C}(\text{CH}_3)(\text{COOH}) \cdot \text{CH}_2 \cdot \text{COOH}.$

238 8 " "was" *read* "were."

239 8 " "heated" *read* "treated."

246 7—12 omit both sentences, printed in error.

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INDEX TO AUTHORS' NAMES.

- Allen, Alfred H., 31.
 Allen, G. W., 157.
 Annable, H., 246.
 Appleyard, J. R., 12, 147.
 Archdeacon, W. H., 8.
 Armstrong, H. E., 42, 43, 44, 45, 167, 230.
 Bablich, H., 106.
 Baker, H. B., 160.
 Ball, John, 235.
 Barnett, R. E., 30.
 Barr, J. M., 168.
 Bentley, W. H., 35, 61, 79, 169.
 Bevan, E. J., 95, 174.
 Blake, R. F., 192.
 Bolam, H. W., 184.
 Bone, W. A., 60, 63, 175, 176.
 Brown, H. T., 241, 242, 243.
 Burgess, H. E., 140.
 Burrell, R. A., 73.
 Cain, J. C., 12, 176.
 Calvert, H. T., 160.
 Carr, F. H., 48.
 Chapman, A. C., 140.
 Chattaway, F. D., 97, 113, 172.
 Chikashigé, M., 151.
 Clowes, Frank, 143.
 Cohen, J. B., 8.
 Collie, J. Norman, 47.
 Cross, C. F., 95, 174.
 D'Arey, R. F., 104.
 Davis, W. A., 230, 231, 233.
 Deeley, R. M., 135.
 Divers, E., 178, 179, 180.
 Dixon, A. E., 99, 100, 223.
 Dixon, H. B., 53, 55, 57, 160.
 Doherty, W. M., 101.
 Doran, R. E., 74.
 Dougal, M. D., 183.
 Dunstan, W. R., 48, 72, 159.
 Durrant, R. G., 96, 244.
 Easterfield, T. H., 76.
 Edwards, W. B., 188.
 Elliott, W. J., 171.
 Evans, Clare de Brereton, 235.
 Evans, R. C. T., 97, 113.
 Ewan, Thomas, 8, 160.
 Fenton, H. J. Horstman, 67.
 Forster, M. O., 145.
 Fortey, Miss E. C., 164, 165.
 Frankland, Percy, 9, 11, 148, 186.
 Gardner, J. H., 187.
 Goulding, E., 72.
 Graham, E., 53.
 Green, A. G., 226.
 Gunnell, O., 158.
 Hada, S., 182.
 Haga, T., 178, 179, 180.
 Hake, H. Wilson, 33.
 Hambly, F. J., 246.
 Harker, J. A., 57.
 Hartley, W. N., 98.
 Haworth, E., 35, 37.
 Heinke, J. L., 155.
 Henderson, G. G., 168.
 Henderson, J., 9, 110.
 Hewitt, J. T., 149, 150.
 Hodgkinson, W. R., 110.
 Holland, T. H., 218.
 Hooker, S., 166.
 Hummel, J. J., 144, 145, 185.
 Humphreys, W. J., 9, 220.
 Hutchinson, A., 30.
 Jackson, D. H., 159.
 Jackson, H., 57.
 Japp, F. R., 107, 109, 146.
 Jerdan, D. S., 60, 175.
 Jowett, H. A. D., 158.
 Kipping, F. Stanley, 77, 114, 152, 188, 215, 229, 247, 249.
 Lander, R. D., 107, 109, 221.
 Lapworth, A., 76, 77, 152, 188, 215.
 Law, Robert, 75.
 Laycock, W. F., 38.
 Leits, Prof., 192.
 Lewes, Vivian B., 1.
 Littleton, Miss F. T., 220.
 Loew, Oscar, 182.

MacGregor, John, 9.
 Mackenzie, J. E., 117.
 Maclaurin, J. S., 149.
 Marsh, J. E., 187.
 Marshall, B. M. C., 146.
 McLeod, H., 141.
 Meldola, R., 49, 51, 125, 163.
 Meyer, V., 153.
 Morris, G. H., 241, 242, 243.
 Murray, T. S., 146.

Newth, G. S., 139.
 Nicholls, A., 138.

O'Sullivan, C., 218.

Patterson, T. S., 153.
 Perkin, A. G., 37, 105, 106, 144, 145,
 157, 158, 167, 185.
 Perkin, W. H., 122.
 Perkin, W. H., jun., 35, 37, 63, 64, 79,
 155, 169, 170, 189.
 Pickard, R. H., 11.
 Pollard, W., 30.
 Pope, F. G., 150.
 Pope, W. J., 116, 142, 177, 217, 249.
 Purdie, Thomas, 96, 221.

Rây, P. C., 217, 218.
 Rettie, Theodore, 178.
 Revis, C., 77, 229, 247.
 Richardson, A., 164, 165.

Roberts-Austen, W. C., 219.
 Ruhemann, S., 73, 166.

Sakurai, Jōji, 38, 181.
 Sell, W. J., 168.
 Smith, Claud, 95, 174.
 Snape, H. Lloyd, 12.
 Sonstadt, E., 236.
 Spivey, W. T. N., 76.
 Stephens, F. R., 103.
 Stephenson, H. E., 149.
 Stern, A. L., 218.
 Strange, E. H., 53.
 Streatfeild, F. W., 49, 51.
 Symons, W. H., 103.

Thorpe, J. F., 64, 155.
 Tickle, T., 159.
 Tilden, W. A., 30, 137, 138.
 Tutton, A. E., 68, 71.
 Tyler, E. A., 73.

Walker, J., 12, 110, 147, 246.
 Walker, J. W., 157.
 Wharton, F. M., 148, 186.
 Williamson, S., 96.
 Wilsmore, N. T. M., 47.
 Wolf, C. G. L., 166.
 Wood, T. B., 13, 76.
 Woolcott, G. H., 163.
 Wray, E., 163.

Young, G., 246.

INDEX TO DISCUSSIONS.

-
- | | |
|---|---------------------------|
| Armstrong, H. E., 29, 60, 228, 244, 245. | Ling, A. R., 228, 244. |
| Cross, C. F., 33. | Lister, Sir J., 26, 60. |
| Dunstan, W. R., 35, 245. | Morley, E. W., 35. |
| Fenton, H. J. H., 33. | Page, F. J. M., 33. |
| Frankland, E., 27. | Poynting, J. H., 29. |
| Groves, C. E., 5, 33. | Rayleigh, Lord, 27. |
| Harcourt, A. Vernon, 5, 25, 29, 35, 245, 246. | Rideal, S., 245. |
| Hehner, O., 33. | Roscoe, Sir H. E., 28. |
| Howard, D., 30. | Rücker, A. W., 5. |
| Kipping, F. S., 227. | Smithells, A., 3. |
| | Thorpe, T. E., 5, 30, 33. |
| | Tilden, W. A., 33. |

INDEX OF SUBJECTS.

- Absorption of moisture by deliquescent salts, 33.
- γ -Acetobutyric acid, its preparation and derivatives, 169.
- Acetonylmalic acid, 73.
- π -Acetoxycamphoric anhydride, preparation and properties of, 115.
- w*-Acetoxy-*cis*- π -camphanic acid, preparation and properties of, 115.
- Acetylene, addition of, to non-luminous flame, 7.
- and oxygen, explosion of mixtures of, 176.
- explosion and detection of, in air, 143.
- flame of, in nitric oxide, 2.
- theory of luminosity, 1.
- Acid compounds of quercetin, morin, luteolin, 167.
- Acids, dilute, absorption of by silk, 147.
- rate of solution in, 235.
- Acidylthiocarbimides, preparation of propionyl-, phenyl, benzyl, and tolyl derivatives of, 100.
- Aconitine, action of methyl alcohol on, 159.
- Acrylic acid, new derivatives of, 170.
- Action of alkaline hypobromites with potassium cyanide, 33.
- Additions to the Library, 84, 112, 118, 128, 162, 194, 239.
- Alcohol, action of hydrogen chloride on, 12.
- Alloys, solution and diffusion of, in mercury, 9, 219, 220.
- Allyl-*p*-dinitrodiazoamidobenzene: the relation between melting point and constitution, 51.
- Amidosulphonic acid, its preparation and properties, 180.
- molecular conductivity of, 181.
- physiological action of, 182.
- Ammoniacal silver nitrate, action of sugars on, 9.
- Ammonium antimonio-malate, its preparation and properties, 168.
- Ammonium antimonio-mucate, its preparation and properties, 168.
- Amyl alcohol, action of light on, 164.
- Amylene chain in lapachol, 166.
- Analysis, a method of spectrographic, 98.
- Anhydractonebenzil and its homologues, 107.
- Anhydractonebenzilcarboxylic acid, properties of, 109.
- Anisole, new derivatives of, 164.
- Anniversary Meeting, 80.
- Armstrong's theory of combustion of carbon monoxide, steam, and oxygen, 55.
- "Armstrong-Nietzki" theory, 228.
- Aromatic amides, action of sodium alcoholate on, 8.
- Aspartic acid, the rotation of, 146.
- Assay balance, an auxiliary, 75.
- Atisine from *Aconitum heterophyllum*, 158.
- salts of, 159.
- Atomic weight of Japanese tellurium, 151.
- Barley straw, the carbohydrates of, 174.
- Barlow's theory of crystal space, 72.
- Beketoff's experiment on combustion of carbon monoxide, 56.
- Benzenoid amines, researches on tertiary. Part II. 234.
- Benzil, condensation of, with acetone-dicarboxylic acid, 109.
- with laevulic acid, 146.
- Benzoylnitroguaiacols, preparation and properties of, 127.
- Berglund's work on the imidosulphonates, criticism of, 179.
- Boric acid, apparatus for the detection of, 161.
- Bran, products of dry distillation of, with lime, 38.
- π -Bromocamphor, its preparation from $\alpha\pi$ -dibromocamphor, 77.
- α -Bromocamphor, sulfolactone from, 247.
- α -Bromocamphorsulfolactone, 247.

α -Bromocamphorsulphonic acid, oxidation products of, 77.

3'-bromo- β -naphthol, formation and properties of, 231.

Cæsium nickel sulphate exhibits double negative refraction, 69.

cis- π -Camphanic acid, crystalline properties of, 116.

Camphenesulphonic acids, derivatives of, 152, 188.

Camphor, halogen derivatives of, 187.

Camphoric acid and acetone, a crystalline compound of, 217.

———— constitution of, remarks on, 110, 191.

———— derivatives of, 114.

Camphoronic acid, remarks on constitution of, 192.

Camphoroxime, a new base from, and its salts, 145.

Camphorsulphonic acid, derivatives of, 216.

cis-Camphotricarboxylic acid and anhydride, preparation and properties of, 115.

Camphylic acids and their derivatives, the isomeric, 189.

Candle flame, temperature of mantle of, 98.

Cannizzaro, Professor, Address to, 120.

Carbohydrates of barley straw, the, 174.

Carbon and hydrogen, direct union of, 175.

———— the union of, 60.

———— dioxide, mode of formation of, on burning carbon compounds, 55.

———— volumetric determination of, 103.

ab-Carboxyethylbenzylthiocarbamide, its preparation and properties, 74.

ab-Carboxyethylisobutylthiocarbamide, its preparation and properties, 75.

ab-Carboxyethylmethylthiocarbamide, its preparation and properties, 75.

ab-Carboxyethyl-*m*-xylthiocarbamide, its preparation and properties, 74.

ab-Carboxyethyl-*o*-tolylthiocarbamide, its preparation and properties, 74.

Carboxyethylphenylsemithiocarbamide, its preparation and properties, 75.

Carboxyethylthiocarbamic acid, methylic, ethylic, propylic, and benzylic salts of, properties of, 75.

ab-Carboxyethylphenylthiocarbamide, its preparation and properties, 74.

Carboxyethylpiperidylthiocarbamide, its preparation and properties, 75.

Carboxyethylphenylbenzylthiourea, its preparation and properties, 75.

Carboxyethylthiourea, its preparation and properties, 75.

ab-Carboxyethyl-*p*-hydroxyphenylthiocarbamide, its preparation and properties, 74.

ab-Carboxyethyl-*p*-tolylthiocarbamide, its preparation and properties, 74.

ab-Carboxyethyl- α -naphthylthiocarbamide, its preparation and properties, 74.

Carboxyethylthiocarbimide and its derivatives, 74.

ab-Carboxyethylethylthiocarbamide, its preparation and properties, 75.

Cathode, rays proceeding from, 59.

Cedrene from cedar-wood oil, preparation and properties of, 140.

Cereal celluloses, constitution of, 95.

Certificates of Candidates, 16, 87, 129, 204.

Charas, the resin of *Cannabis Indica*, examination of, 76.

Chemical constitution, relationship of, to rotatory power, 10.

Chloral hydrate crystals, localisation of deliquescence in, 249.

Chlorine, liberation of, during preparation of oxygen, 141.

———— peroxide, explosion of, 57.

Chlorobenzeneazosalicylic acids, the three, and their methyl and ethyl salts, 149.

Chlorocamphene, constitution of, 188.

———— hydrochlorides, 187.

α -Chlorocamphenesulphanilide, preparation and properties of, 152.

β -Chlorocamphenesulphanilide, preparation and properties of, 153.

α -Chlorocamphenesulphochloride, preparation and properties of, 152.

β -Chlorocamphenesulphochloride, preparation and properties of, 152.

β -Chlorocamphenesulphonic acid, preparation and properties of, 153.

π -Chlorocamphoric acid and anhydride, 216, 217.

Chlorofumaric acid, formation of pyrazolone derivatives from, 166.

α -Chloronitrocampbor, the products of the decomposition of, 76.

Chrome alum, the effect of heat on aqueous solutions of, 183.

Chromsulphuric acid, colloidal, 160.

Circular polarisation of crystals, true and simulated, 116.

Citrazinic acid. IV. 168.

Citrene and pinene, relation of, 44.

Claisen's camphorquinone, from isonitrosocampbor prepared from α -chloronitrocampbor, 76.

Cobalt, a new compound of, 96.

- Cobalt, detection of, in presence of nickel, 96
- Cobaltous salts, action of oxidising agents on, in presence of alkali bicarbonates, 244.
- green colour of, 244.
- Colour change due to heat alone, 227.
- origin of. XI. The yellow colour of 2:3-hydroxynaphthoic acid, 42.
- Combustion of carbon compounds, 55.
- Comparison of the results of the investigations of the simple and double sulphates containing potassium, rubidium, and caesium, 71.
- Composition of a "white sou," 98.
- Constituents of "charas," 76.
- Constitution and colour. 226.
- of camphoric acid, 110, 191.
- of camphoronic acid, 192.
- of chlorocephene, 183.
- of the acid resulting from the oxidation of tartaric acid, 67.
- Conversion of α_j into $\alpha[p]$, the factors for the, 242.
- Cryoscopic determinations of molecular weight in benzene, ethylene dibromide, nitrobenzene, and acetic acid, 11.
- Crystalline salts, refraction constants of, 177.
- Crystallisation, causes which modify it, 72.
- Crystallographic data of β -naphthol derivatives, 233.
- Crystallography of mercurous nitrite, 218.
- Crystals, deposition of, 250.
- Cupric reducing power of maltose, Wein's tables, 244.
- Cyanate of silver in the determination of urea, 33.
- Cyanates, transformation of alkylammonium, into ureas, 12.
- Cyanide solutions of gold-silver alloys, 149.
- Cyanogen, rate of explosion of, 53.
- Deaths of Fellows during past session, 82.
- Dehydracetic acid, condensation products of, 47.
- Deliquescence of chloral hydrate crystals, 249.
- Desylacetic acid from desyleneacetic acid, 109.
- preparation of, 108.
- Desyleneacetic acid, preparation of, 107.
- reduction of, 109.
- Detection of cobalt in presence of nickel, 96.
- Determination of the chlorine liberated during the preparation of oxygen from potassic chlorate and manganic peroxide, 141.
- Dextrose from different sources, identity of, 218.
- Diastase, examination of products of starch-hydrolysis by, 241.
- Diazoamides, mixed, containing an orthonitro-group, 49.
- Dibenzoyldiphenylmethane, preparation and properties of, 117.
- Diethoxydiphenylmethane, preparation and properties of, 117.
- Diethylammonium chloride, electrical conductivity of, 246.
- Diffusates of chrome alum, 184.
- Diffusion of metals in mercury, 9, 219.
- Dilute acids, rate of solution of zinc in, 235.
- Dimethyldiphenylmethane, preparation and properties of, 117.
- Dimethylglutaric acids, separation of, 63.
- $\alpha\alpha_1$ -Dimethylglutaric acids, note on, 63.
- Dimethylhexamethenylmalonic acid, synthesis of, 188.
- Dimethylketohexamethylene, preparation of, 188.
- preparation of oxime of, 248.
- Dimethylsuccinic acids, the symmetrical, their preparation and properties, 63.
- Diphenoxyethylacetic acid, preparation and properties of, 36.
- Diphenoxyethylmalonic acid, preparation and properties of, 36.
- $\beta\gamma$ -Diphenylbutyric acid preparation of, 110.
- Diphenylcyclopentane, preparation of, 108.
- Diphenylcyclopentenone, preparation of, 108.
- from anhydride acetonebenzilcarboxylic acid, 109.
- Diphenylcyclopentenonylacetic acid, 147.
- Diphenyldihydroxyglutaric acid, preparation of, 108.
- Diphenylfumaric acid, preparation of, 109.
- $\beta\gamma$ -Diphenyl- γ -hydroxybutyric acid, preparation of, 110.
- Diphenylhydroxycyclopentenone, 107, 147.
- Diphenylhydroxycyclopentenonylacetic acids, the two isomeric, 147.
- Diphenylmaleic acid, preparation of, 109.
- Ditoluyltartronic acids, rotation of the

- methylic and ethylic salts of the three, 148.
- "Divisor" method of determining total solids in the product of starch-hydrolysis, 242.
- Duggan's method of determining urea, 32.
- Dyeing, a chemical addition of the dye to the fibre, 148.
- Dyer's method of estimating potash, 12.
- Election of Fellows, 41, 103, 137, 225.
- Electrical conductivity of diethylammonium chloride, 246.
- Electrolysis of salts of monhydroxyacids, 157.
- Electrolytic conductivity of formanilide and thioformanilide, 8.
- Enantiomorphism, 249.
- Ether, action of light on, 165.
- Ethereal salts of optically active malic and lactic acids, 96.
- Etherification, note on, 43.
- Ethyl benzoylglycerate (active), properties of, 10.
- bromhexahydroparaxylylate, properties of, 79.
- dibenzoylglycerate (active), properties of, 9.
- dicarboxylglutaconate, hydrolysis of, 184.
- hexahydroparaxylylate, properties of, 79.
- α -hydroxy- $\alpha\alpha\beta$ -trimethylglutarate, its preparation and properties, 156.
- β -hydroxy- $\alpha\alpha\beta$ -trimethylglutarate, its preparation and properties, 156.
- isopropylmethylethanetricarboxylate, 64.
- isopropylpropanetricarboxylate, its preparation and properties, 155.
- methyl dihydrofurfuranetricarboxylate, its preparation and properties, 73.
- α -methyl- β -hydroxyvalerate, its preparation and derivatives, 156.
- methylisopropyl- α -bromacetate, its preparation and properties, 144.
- γ -phenoxyethyl- α -methylmalonate, preparation and properties of, 36.
- thioalcophanate of Peitzsch a pseudothiurea, 75.
- Explosibility of acetylene in air, limits of, 143.
- Explosion wave of carbon monoxide, rate of, 55.
- of chlorine peroxide, 57.
- Explosion of cyanogen, 53.
- of mixtures of acetylene and oxygen, 176.
- Ferrous sulphate, oxidation of, by sea water, 237.
- Fellows removed from the list, 81.
- Fisetin, quercetin, and luteolin, relation between, 105.
- the colouring matter of *Quercus brachy colorado*, 158.
- Flame, cause of brightness in, 6.
- division of, into two zones, 2.
- of a candle, temperature of mantle of, 98.
- of acetylene burning in nitric oxide, 2.
- of cyanogen explosion, 54.
- structure of, 6.
- Fluorene and acenaphthene, the oxidation products of, 110.
- Formanilide, conductivity of, 8.
- feeble acidic properties, 8.
- Freundler's theory, discussion of, 11.
- Furfural of cereal celluloses, the constitution of the, 96.
- Galamer's so-called "methylallylthiocarbamide dibromide," 100.
- Glutaric acid, new derivatives of, 170.
- Glycocine, constitution of, 38.
- Glycol, preparation of concentrated solution of, 37.
- Gold, action of sulphur on alloyed, 149.
- assay, improved auxiliary balance for, 76.
- detection of, in sea-water, 238.
- Green solutions from cobaltous salts, 244.
- Guaiacol, new derivatives of, 164.
- Halogen derivatives of camphor, 187.
- Heat of formation of silver amalgam, 220.
- Helmholtz Memorial lecture, 25.
- Hemp, Indian, the active ingredient of, 76.
- Hexahydroparaxylic acid from paraxylic acid, 79.
- chloride, properties of, 79.
- Hydration of certain deliquescent salts, 35.
- Hydriodides of hydroxylamine, 72.
- α -Hydrindone, derivatives of, 229.
- Hydrogen chloride, action of, on alcohol, 12.
- peroxide, formation of, by action of light on amyl alcohol and ether, 165.

Hydrolysis of ethylic dicarboxylglutamate, 184.

m-Hydroxy-*cis*- π -camphanic acid, properties and preparation of, 115.

Hydroxydibromocamphorsulphonic acid, 78.

Hydroxylamine sulphate, preparation of, 178.

———— the hydriodides of, 72.

Hypochlorites and hypobromites, action of alkaline, on urea, 33.

Hyponitrites of mercury, 217.

Imidosulphonates. Part II, 179.

Inversion of optically active compounds, conditions of, 44.

Iodine compounds with metallic hydroxides, 178.

Iodoso- and iodoxy-benzaldehydes and their derivatives, preparation of, 153.

Isocinnamylmandelic acid, preparation and properties of, 108.

Isophenethylmandelic acid, preparation of, 108.

a-Isopropylacrylic acid, 154.

a-Isopropylglutaric acid, 153, 154.

Isopropyl isopropoxysuccinate, formation of, and rotatory powers of, 222.

Isoquinoline derivatives from dehydroacetic acid, 47.

Kelvin, Lord, address to, 121.

β -Ketonic acids, contributions to the knowledge of, 166.

Ketopinic acid from pinene, and its salts, 167.

Knarsborough, analysis of water from the dripping well at, 73.

Lactones of trans-camphotricarboxylic acid, 115.

Lapachol, the constitution of. Part III, 166.

Laurolene from potassium alloethylic camphorate, 110.

Lead tetracetate, formation and properties of, 31.

Lenard's experiments with vacuum tubes, 58.

Leuco-compounds of dye-stuffs, scheme of classification depending on behaviour of, 226.

Light, action of, on amyl alcohol, 164.

———— ether, 165.

Lomatol, 166.

Luminosity, acetylene theory of, 1.

Luteolin. Part II, 105.

———— composition and formula of, 37.

———— fisetin and quercetin, relation between, 105.

Malate of silver, action of alkyl iodides on, 221.

Maltose, cuprie reducing power of, 244.

———— Ost's determination of specific rotation of, 243.

Maly's so-called thiosinamine dibromide, 99.

Mendeléeff's table, position of tellurium and iodine, and of cobalt and nickel, in, 152.

———— theory of combination between gases, 56.

Mercurous and mercuric salts, the interchange of, 182.

———— nitrite and ethyl iodide, action of, 218.

Mercury hyponitrites, 217.

———— nitrites, 218.

———— solution, and diffusion of metals in, 9, 219, 220.

———— use of, in detecting gold in sea water, 238.

Metadichlorobenzene, method for obtaining in bulk, 97.

Metadiphenylbenzene, synthesis of, 113.

———— properties of, 114.

Metamidobenzoic acid, action of chloroform and potash on, 171.

Metaphosphoric acid, molecular weight of, 30.

Methane, formation of, by union of its elements, 60.

———— from the direct union of carbon and hydrogen, 175.

———— presence of, in nitrogen, determined by the absolute method in aconitine, 48.

Methylbenzaconine, its preparation and properties, 159.

a-Methylbutyrolactone, preparation and properties of, 36.

Methylic benzoylglycerate (active and inactive), properties of, 10.

———— *cis*- π -camphanamate, properties and preparation of, 115.

———— dibenzoylglycerate (active and inactive), properties of, 9.

———— diphenylacetyl glycerate (active), properties of, 10.

———— dipropionyl glycerate (active), properties of, 10.

———— methylterephthalate from pseudocumene, 79.

Methylisophthalic acid from pseudocumene, 79.

Methylisopropylsuccinic acids, the *cis*- and *trans*-, 64.

Meyer, Lothar, Memorial Lecture, 119.

Molecular conductivity of amidosulphonic acid, 181.

Molecular rotation of aromatic compounds, 122.

----- weight of phosphoric anhydride and metaphosphoric acid, 30.

Molybdi-tartrates of alkali metals, 169.

Mononitroguaiacol, preparation, properties, and derivatives of, 125.

Morin, probable constitution of, 107.

----- prepared from old fustic and jackwood, 106.

Morphotropic relations of β -naphthol derivatives, 233.

Myrica nagi, colouring matter of, 145.

Myricetin, the colouring matter of Sicilian sumach, 157.

----- principle of
Myrica nagi, preparation and properties of, 145.

β -Naphthol derivatives, crystallography of, 233.

Naphthalene derivatives from dehydracetic acid, 47.

Nitration, notes on, 230.

Nitrites of mercury, 217.

Nitrogen, a difficulty in the determination of, by the absolute method, 48.

----- iodide, its preparation, 173.

----- method of analysis, 173.

----- proposed formula for, 174.

Nitro- β -naphthols, derivatives of, 231.

Nitrosulphates, reduction of, 179.

Nitroxyl group, state of the oxygen in, 123.

Numerical strength of the Society, 81.

Officers and Council for the year 1896-7, 83.

Oil obtained from "Charas," its properties, 76.

Onion (*Allium cepa*), colouring matter of, 144.

Optical activity of ethereal salts of malic and lactic acids dependent on the method of formation, 97.

----- relationships of the potassium, rubidium, and cesium salts of the series $R_2M(SO_4)_2 \cdot 6H_2O$, 68.

Ortho-substituents, influence of, in preventing alkylation of the carboxyl group, 51.

Ost's determination of specific rotation of maltose, 243.

Oxime of π -bromocamphor, its properties, 77.

----- of dimethylketo-hexamethylene, preparation and properties of, 248.

Oxygen, explosion of cyanogen with, 54.

----- preparation of, from potassic chlorate and manganic peroxide, 141.

Oxytriazoles from phenylsemicarbazide, formation of, 246.

Ozone, apparatus for experiments with, 139.

Palmityl substituted thio-carbamides and -ureas, 223.

Peitzsch's "ethylic thioaleophanate" a pseudothiurea, 75.

Pentacarbon rings, synthesis of. Part I. Anhydrazetonebenzil and its homologues, 107.

Periodic law, the, 185.

Periodicals received in the Library, 198.

Pettenkofer's method for determining carbon dioxide in the air, 192.

Phenol, new derivatives of, 163.

Phenoxyethylbromide, action of, on substituted propanetricarboxylates, 170.

α -Phenoxyethyl- γ -hydroxybutyric acid, preparation and properties of, 36.

γ -Phenoxyethylmalonic acid, preparation and properties of, 35.

γ -Phenoxyethyl- α -methylacetic acid, preparation and properties of, 36.

γ -Phenoxyethyl- α -methylmalonic acid, preparation and properties of, 36.

γ -Phenoxybutyric acid, preparation and properties of, 35.

Phenylene phenylenethiocarbamate (*m*- and *p*-), preparation and properties of, 12.

Phenylhydrazine, action of formic aldehyde on, 157.

----- on anhydrazetonebenzilcarboxylic acid, 109.

Phenylsemicarbazide, oxytriazoles from, 246.

Phenylthiocarbimide, action of, on phenol, resorcinol, quinol, and glycol, 12.

Phloroglucol from luteolin, 105.

Phosphorescent substances and the X-rays, 57.

Phosphoric anhydride, molecular weight and formula of, 30.

----- volatility of, 30.

Picric acid, absorption of, by silk, 147.

Pinene, action of bromine on, 137.

----- and citrene, relation of, 44.

----- proposed formula for, 138.

----- tetrabromide, derivatives of, 138.

Polarisation of crystals, true and simulated circular, 116.

Polymorphism of chloral and bromal hydrates, 142.

Position isomerism and optical activity. Part I. 148.

the rotatory powers of the dibenzoyl- and ditoluytartrates, 186.

Potash in soils, the available, 12.

Potassium allo-ethylic camphorate, hydrolysis of. Part II. 110.

— cyanide, action of, on gold-silver alloys, 149.

— platinocyanide, a phosphorescent substance, 58.

Propionic acid, new derivatives of, 170.

Propylic dibenzoylglycerate, (active) properties of, 10.

Pyrazolone derivatives from chlorofumaric acid, 166.

Pyroammaric acid of Zinin; its formula, 110.

Pyrocatechol, new derivatives of, 164.

Querbracho colorado, the colouring matter of, 158.

Quercetin, colouring matter of the wall-flower, 186.

white hawthorn, 186.

— group of natural yellow colouring matters, a distinctive reaction, 168.

— in the bulb of the onion, 144.

— luteolin and fisetin relation between, 105.

Quinonoid, theory of colour in dye-stuffs, 227.

Rate of formation of gases from the direct union of carbon and hydrogen, 177.

Rates of transformation of cyanates into ureas, 12.

Reaction of urea and sodium hypochlorite, anomalous, 33.

Recoura's "chromopolysulphuric" acids, 160.

Refraction constants of crystalline salts, 177.

— method of determining them, 178.

— of saturated and cycloid compounds, differences in, 124.

Relation between cryoscopic determinations of molecular weight in various organic solvents, and rotatory power, 112.

— specific rotatory and cupric-reducing powers of starch-hydrolysis products, 244.

Replacement of potassium by rubidium, or rubidium by caesium, effect on volume and optical relationship, of their double salts, 69.

Researches on tertiary benzenoid amines. Part II. 234.

Residual gas in vacuum tubes, 58.

Resignations, 81.

Resorcinol, condensation of chloral with, 150.

Röntgen rays, 56, 57 *seq.*

— the chemical inactivity of, 100.

Rotation of methyl-dibenzoyl glycerate in various organic solvents, 11.

Rotatory power in both crystalline and liquid states, substances which exhibit, 116.

— of a substance cannot be calculated from that of its solution, 11.

— magnetic, of aromatic compounds, 122.

— relationship of, with chemical constitution. 10.

— powers of isopropylates, 221.

— of the dibenzoyl- and ditoluytartrates, 186.

Salts, foreign, the action of, in affecting the rate of solution of zinc in dilute acids, 236.

Santalal and its derivatives, 140.

— preparation and properties of, 140.

Santalenic acid, preparation of, 140.

Sea water, detection of gold in, 238.

— oxidation of ferrous sulphate by, 236.

Seidel's so-called ethylic phenylthioaleophanate, and "isophenylthioaleophanate;" their composition, 75.

Semicarbazone of dimethylketohexamethylene, 249.

Separation of cis- and trans-dimethylglutaric acids, 63.

Silk, absorption of dilute acids by, 147.

Silver amalgam Ag_2Hg_3 , heat of formation of, 220.

Sodium alcoholate, action of, on aromatic amides, 8.

— sulphate solutions, condition of the dissolved substance in, 104.

Solution and diffusion of metals in mercury, 220.

— of metals in mercury, 9, 219.

Specific rotation of maltose at varying concentrations, 243.

— soluble starch, 243.

— rotatory power, methods of determination, 242.

- Spectrographic analysis, 98.
 Starch-hydrolysis, examination of products of, by diastase, 241.
 Statistics relating to the abstracts, 82.
 Stearyl substituted thiocarbamides and ureas, 223.
 Structural unit of crystals, considerations bearing on, 71.
 Sugars, action of, on ammoniacal silver nitrate, 9.
 Sulphocamphoric acid, 215.
 ————— anhydride, 216.
 Sulphocamphylic acid, derivatives of, 189.
 Sulpholactone of dibromocamphorsulphonic acid, 78.
 Sulphonation of substituted anilines and toluidines, 234.
 Sulphur, action of, on alloys of gold, 149.
 Sumach, Sicilian (*Rhus coriaria*), the colouring matter of, 157.
 Symons and Stephens' method for the determination of carbon dioxide, criticism of, 193.
 Synthesis of pentacarbon rings. Part II. Condensation of benzil with acetonedicarboxylic acid, 109.
 ————— Part III. Condensation of benzil with lævulic acid, 146.
 Tartaric acid, a new acid from the oxidation of, 67.
 Tartrates, rotatory powers of the dibenzoyl- and ditoluy-, 186.
 Tellurium, atomic weight of Japanese, 151.
 Temperature, influence of, on magnetic rotatory power, 122.
 ————— of flames, measurement of, 98.
 ————— inner zone of flame, 2.
 Terpenes, researches on. Part VII. 187.
 Tetrabromomorin, preparation, properties, and compounds of, 106.
 Tetrahydroparaxylic acid from paraxylic acid, 79.
 Tetrahydroxydiphenylacetic acid from resorcinol, 151.
 Thermochemical peculiarities of bromal and chloral hydrates, 142.
 Thermocouple, use of, in a flame, 5.
 Thiocarbimides from complex fatty acids, 223.
 Thioformanilide, conductivity and properties of, 8.
 Thiosinnamines, additive products of substituted, 99.
 Thomson's theory of combustion of carbon monoxide, steam, and oxygen, 55.
 Trans- π -camphanamide, properties and preparation of, 115.
 ——— π -camphanic anhydride, properties and preparation of, 115.
 ——— camphotricarboxylic acid and anhydride, preparation and properties of, 115.
 Treasurer's statement, 83.
 Tribromocamphene hydrobromides, 187.
 Trimethylacrylic acid and its derivatives, 154.
 ————— its preparation and properties, 157.
 Tungsti-tartrates of the alkali metals, 169.
 Urea, action of hypochlorites and hypobromites on, 33.
 ——— action of sulphuric acid and potassium dichromate in presence of a nitrate, 33.
 ——— determination of, by the hypobromite process, 31.
 Ureas, transformation of alkyl ammonium cyanates into, 12.
 Vacuum tubes, Lenard's experiments with, 58.
 Volatility of phosphorus pentoxide, 30.
 Volume relationships of the potassium, rubidium, and cesium salts of the series $R_2M(SO_4)_2 \cdot 6H_2O$, 68.
 Wallflower, *Cheiranthus cheiri*, colouring matter of, 185.
 Water from the Dripping Well, Knaresborough, 73.
 Wein's tables for cupric reducing power of maltose, 244.
 White hawthorn, *Crataegus oxyantha*, colouring matter of, 186.
 Zinc, rate of solution in dilute acids, 235.

PROCEEDINGS

OF THE

CHEMICAL SOCIETY.

EDITED BY THE SECRETARIES.

No. 159.

Session 1895-96.

January 16th, 1896. Mr. A. G. Vernon Harcourt, President, in the chair.

Messrs. A. J. Chapman, H. W. Dickinson, G. Goldfinch, E Grossman, and A. F. Theodosius were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. William Henry Bentley, B.Sc., 116, Yarburgh Street, Moss Side, Manchester; Joseph John Bowley, 34, Elm Park Road, Chelsea; Daniel Bray, Broadmoor, Cinderford; Hugh Charles Herbert Candy, B.A., B.Sc., 101, Gower Street, W.C.; Thomas Ewan, B.Sc., Ph.D., Yorkshire College, Leeds; Charles James Pemeller Fuller, Mona House, Horwich, Lancs.; William Harrington, 11, Edgehill, Whitehaven; Albert Howard, 17, Elthiron Road, Fulham, S.W.; Ernest Haynes Jeffers, 50, St. John's Hill Grove, New Wandsworth. S.W.; James Johnstone, Braehead, Parkhill, Rutherglen; Charles Edward Sage, 7, Oseney Crescent, N.W.

Of the following papers those marked * were read :—

*1. "The acetylene theory of luminosity." By Vivian B. Lewes.

The author points out that in 1882 Professors Dewar and Living (Proc. Roy. Soc., 34, 438) came to the conclusion that the "formation of acetylene in ordinary combustion seems to be the agent through which a very high local temperature is produced," whilst Gueqnen (*Trans. Société Technique*, 1884) claims to have put forward the acetylene theory of luminosity in 1884.

The author considers that the criticism offered against the acetylene theory by Smithells (Trans., 1895, 67, 1049) in no way affects the considerations upon which the theory is based, which are—

1. That the unsaturated hydrocarbons in the inner region of the flame are largely converted into acetylene before luminosity commences.

2. That acetylene develops luminosity when heated whilst flowing through a hard glass tube, no air being present.

3. That the temperature necessary to decompose acetylene with evolution of light does not raise to incandescence the carbon liberated by the decomposition.

4. That in luminous hydrocarbon flames of sufficiently high temperature the luminosity varies directly with the amount of acetylene present at the point where luminosity commences.

The objections raised by Smithells against the determination of absolute temperatures in flames by means of the Le Chatelier thermocouple are warmly endorsed by the author as far as those portions are concerned in which combustion is taking place, and these objections were pointed out in his former paper (*Proc. Roy. Soc.*, 57, 452), but he contends that the results obtained in the inner non-luminous portion of a hydrocarbon flame are probably fairly accurate, and the results obtained by Smithells fully confirm the statement that the temperature in the inner zone rises from a comparatively low temperature close to the burner to over 1000° at the apex of the zone.

The author describes experiments showing that although the heat of combustion of acetylene is very high, so small a proportion has to be burnt in order to develop the remaining energy as light and radiant heat that it by no means follows that the acetylene flame is hotter, or even as hot, as a coal gas or ethylene flame of the same size.

Smithells has come to the conclusion that the statement that cyanogen could be made to undergo luminous combustion has arisen from a yellow ammonia flame having been mistaken for one containing solid carbon; the author shows that by surrounding the cyanogen flame by nitric oxide, intense luminosity and a copious deposit of soot can be obtained.

The author contends that the flame is in reality divided into two zones—

1. The outer sheath of combustion,
2. The inner region of non-combustion,

and that the latter consists of an internal portion in which radiant heat is converting the hydrocarbons into acetylene: a luminous envelope which caps it, and in which more intense heat is decomposing the acetylene with emission of light, and the blue calyx at the bottom of the inner zone where the hydrocarbons are undergoing de-

composition by water vapour and carbon dioxide without previous separation of carbon.

The author also contends that the incandescent carbon particles in the upper portion of the flame are acted upon by carbon dioxide and water vapour forming carbon monoxide and hydrogen, and that this action tends far more than combustion by the air to prevent their escape from the flame.

DISCUSSION.

Professor SMITHELLS said that he had always considered the acetylene theory ingenious, and feared indeed that its very attractiveness had led Professor Lewes to a one-sided and, in many cases, an erroneous interpretation of evidence. The question was not whether the explanation of luminosity afforded by the acetylene theory was conceivable, but whether the theory was really in harmony with ascertained facts; and this question, he still thought, was to be answered decidedly in the negative. As Professor Lewes had not read the whole paper, but had only drawn the attention of the meeting to certain points, he was unable to say to what extent Professor Lewes had dealt with the series of objections raised to the theory, and his remarks must not, therefore, be regarded as pretending to be a complete reply.

He wished that Professor Lewes would state explicitly what view he had as to the structure of an ordinary gas flame. Did he, or did he not accept the old and generally accepted view, that the flame consisted of three distinct parts—a luminous region, a mantle, and a blue calyx at the base? Professor Lewes had attempted to define the parts of flame by reference to temperatures; and whereas at one time he indicated the mantle as the region of lowest temperature, he now appeared to agree that it was the hottest part. Did he still maintain temperature measurements to be a reasonable basis for defining the anatomy of the flame?

He did not consider that Professor Lewes had explained the extraordinary discrepancies that had been pointed out in his measurements of temperature; and he should like to know whether Professor Lewes had used the thermo-couple, as shown in the apparatus before them, or whether he had not, as implied in his previous papers, inserted the twist of the thermo-couple in a manner now admitted to be improper.

He still thought that it was misleading to speak of 80 per cent. of the unsaturated hydrocarbons as being converted into acetylene within the flame. If acetylene were the source of light, and if the light depended on the almost explosive character of its decomposition, there surely was some reason to ask for evidence that a mixture

of gases containing 1·4 per cent. of acetylene, 0·5 per cent. of other unsaturated hydrocarbons and 98 per cent. of other gases (four-fifths of which were incombustible) could afford light in the manner stated. He considered that such a doctrine was incredible.

The evidence now adduced by Professor Lewes to show not that the acetylene flame was comparatively cool, but that, conceivably it might be so if the fact were not otherwise, was very remarkable. He could not exactly say what was the mechanical equivalent of light, but his recollection was that it was extremely small, and he advised Professor Lewes to look into what was known on this subject before committing himself to the view that the acetylene flame lost so large a fraction of its total energy in the form of light. However, this seemed to be a matter of little consequence, for there was no getting over the fact that the acetylene flame was surrounded by a mantle of extremely high temperature, and that a platinum wire introduced into it glowed at least as brightly as the carbon within the flame. That being the case, there was no occasion to explain that, hypothetically, the flame might be cool.

With regard to the cyanogen flame, he had nothing to withdraw from what he had said on a previous occasion, though he gladly congratulated Professor Lewes on having now made a new and interesting observation. He had entirely failed to obtain evidence of carbon being separated in a cyanogen flame surrounded by burning hydrogen, and Professor Lewes had not shown that it was separated. The use of nitric oxide (which would in its luminous result remind them of the behaviour of that gas towards carbon disulphide) undoubtedly led to the separation of carbon, and supplied a piece of evidence which Professor Lewes was now entitled to claim.

Much circumstantial evidence, believed by Professor Lewes to favour the acetylene theory, had been adduced. Among it was a calculation which, having a striking practical aspect, might have considerable influence on some minds, and he desired to ask Professor Lewes to explain and justify it. It was intended to give the theoretical illuminating value of ethane, ethylene, and acetylene respectively, on the supposition that in giving light after passing through the state of acetylene they were resolved into carbon and hydrogen, and this calculation gave results in tolerable agreement with the illuminating value of the gases as determined by the photometer. The calculation was, he thought, unintelligible from a scientific point of view, but, even if the principle were admitted, seemed not only incorrectly made, but capable of affording a set of numbers entirely at variance with practical measurements, just as easily as numbers in harmony with them. He thought some explanation of this was due from Professor Lewes. He would only, in conclusion, say again

that his remarks must not be taken at all as his complete answer to Professor Lewes, whose manner of presenting his paper had rendered this impossible.

Professor RÜCKER thought that the use of a thermo-couple in a flame above the melting point of one of the metals was open to grave objection, on account of the uncertainty as to the temperature which the junction actually attained. The validity of Professor Lewes' experiment on the thermal value of the luminous radiation depended on whether the whole of the non-luminous radiation had been absorbed in the comparison experiment. This in turn depended in part on the dimensions of the apparatus. By the solution of a small quantity of an iron salt the absorptive power of the water would have been increased, while the light would not have been very largely diminished.

Professor THORPE remarked that a possible fallacy might underlie the deductions as to temperature drawn from the behaviour of a platinum wire in a flame containing free carbon and carbonic oxide, on account of the specific chemical action which those substances might exert on the metal. The fact that a platinum wire would melt even in an ordinary candle flame, which is not particularly hot, was known to Smithson Tennant, and is referred to by Davy in his well-known paper. Davy also found that a filament of platinum could be fused by a flame of cyanogen in air, whereas the same wire was not melted by a hydrogen flame.

Mr. GROVES drew attention to Professor Lewes' statement that the yellow light emitted by a jet of cyanogen when surrounded by a hydrogen flame was due to carbon liberated by the decomposition of the cyanogen, and suggested that if the image of the sun were thrown on to this flame by means of a lens, and the reflected light examined by methods familiar to physicists, it would be easy to ascertain whether the flame contained solid particles. In that case, not only would the light be found to be polarised, but, if examined spectroscopically, would exhibit the Fraunhofer lines. If the flame contained no solid particles, then the luminosity could not be due to liberated carbon; on the other hand, even if it were found to contain solid particles, it would not necessarily follow that these were carbon.

The PRESIDENT referred to a suggestion of Professor Lewes that the great output of light from the acetylene flame may leave the flame itself comparatively cool. He thought that of the energy made kinetic by chemical changes within the flame only a small part radiated out in waves of such a length as to be light. The small carbon particles in the flame lost much heat by radiation, and would thus be cooler than the non-radiating gases in which they

floated. It was agreed that the outside of a flame was the hottest part. One of the causes of the splendour of the flame of pure acetylene was, no doubt, the high temperature to which the separation, as well as the oxidation, of the carbon and hydrogen contributed; but a suitable burner was necessary: the flame must have a large outer surface, and close within this must be spread over the whole frontier, the little particles of carbon which glow for an instant and disappear.

Among the causes which make the flame of one gas brighter than that of another might be a difference in the size and number of these solid particles. As one salt gave a large-grained and another a small-grained precipitate, so it might be with decomposing hydrocarbons; and as a given quantity of platinum wire coiled into a spiral and held in a Bunsen flame would give more light the smaller the gauge, so the finer dust of carbon might make the brighter flame.

Some idea of the proportion between the surface of the flame and the actual surface of the glowing particles to which its light is due might be gained from a comparison with the filament of an electric glow-lamp. The radiating substance was similar in the two cases, and when the filament and current were such that the glow-lamp gave light of the same amount and colour as the gas-flame, it was likely that the glowing surfaces had a similar area.

Professor LEWES, in reply, said that he extremely regretted not having read his paper *in extenso*, as it contained answers to most of the objections advanced by Professor Smithells.

His views as to the structure of an ordinary gas flame were that it contained four parts, but that three of these, namely, the non-luminous inner zone, the luminous sheath, and the blue calyx were portions of the region in which no combustion, in the ordinary acceptance of the term, took place; whilst the outer mantle of the flame was the region of intense combustion, and is undoubtedly the hottest part of the flame. In a paper read in 1892, he had given a description of the structure of a gas flame, but, in criticising this, Professor Smithells had evidently overlooked the fact that the portion of the paper following the description was devoted to an investigation as to the causes which led to the non-luminosity of hydrocarbon flames, which showed that the outer envelope must be the hottest portion of the flame, but it is also manifest that the outer side of this mantle must be rapidly cooled by admixture with air and products of combustion, so that the maximum temperature will be near the inner side of this region, and it was the extreme outer portion of this zone which he had described in the words criticised by Professor Smithells.

He thoroughly agreed in condemning any temperature measurements of those portions of the flame in which active combustion was going on, but still believed in the measurements obtained in the area of non-combustion. Professor Smithells had pointed out that serious discrepancies existed between the temperatures recorded in a flat flame in the 1892 paper and in the 1895 paper, but as the one was from a No. 6 Bray, whilst the other was given by a 0000 Bray, it was difficult to understand on what grounds it could be expected that they would show any agreement, as the temperatures varied for every alteration in the size of the burner, and for every variation in the pressure at which the gas was burnt.

One of Professor Smithells' strongest points was that it was misleading to speak of 80 per cent. of the unsaturated hydrocarbons being converted into acetylene within the flame—the statement he had made was that 80 per cent. of the unsaturated hydrocarbons at the point just before luminosity commenced consisted of acetylene.

If a mixture of 1·5 per cent. of acetylene and any gas which had a non-luminous flame was burnt, no luminosity would be generated, and no trace of acetylene would be detected at the top of the inner zone, it having been consumed before the temperature necessary for its decomposition was reached; but if 1·5 per cent. of acetylene was led into the top of the inner zone of a flame of coal gas, from which the unsaturated hydrocarbons had been absorbed, then this addition would make the flame as luminous as if the unsaturated hydrocarbons had not been withdrawn, and he thought that Professor Smithells' doubt as to the truth of the acetylene theory was based largely on a misconception of this point.

As regards the experiments to show that a flame radiates a considerable amount of energy when emitting light, he was perfectly in accord with those who pointed out that the amount of energy converted into light was but small; there was also a large amount of heat radiated, and the experiment with the blackened bulb would give the total radiation cut off by the opaque coating, which when the flame was radiating freely would be lost to the flame. It would be preposterous to lay any great stress on this experiment, as the products of combustion were practically escaping uncooled.

He had made in a former paper a calculation to show that a ratio existed between the heat of formation of a hydrocarbon and its illuminating value, but he had been careful to point out that in our present absence of knowledge as to the heat relations existing at high temperatures, any such calculations were valueless except as showing that the greater the endothermic value of a compound the higher was its illuminating value.

Professor Smithells concludes that because a platinum wire held in

the outer shield of a flame glows with the same incandescence as the carbon particles in the flame itself, therefore there is no need to assume any other source of heat than that given by the combustion going on in the flame walls.

He thought that this conclusion was based upon at least two fallacies. In the first place Professor Smithells had himself clearly pointed out that there is a temperature gradient on the horizontal plane in which there is an abrupt rise in temperature from the luminous sheath to the point of maximum combustion in the external envelope, and it therefore follows that the platinum wire held in the external envelope must be heated to a higher temperature than the carbon particles in the luminous sheath. Secondly, the conclusion is based upon the assumption that the emissive power for light of carbon and platinum is the same, which is highly improbable. It has been shown that metals at high temperatures reflect light, and he thought it quite possible that some of the apparent brightness of the platinum wire might be due to light reflected from the luminous veil in front of which the wire was placed.

2. "The action of sodium alcoholate on certain aromatic amides."

By J. B. Cohen, Ph.D., and W. H. Archdeacon, B.Sc.

If acetanilide is dissolved in ether, and sodium methylate added, a crystalline addition compound of the formula $\text{Ph}\cdot\text{NH}\cdot\text{Ac}, \text{CH}_3\cdot\text{ONa}$ is formed.

Similar compounds with sodium methylate and ethylate have been prepared from ortho- and para-acetoluide, α - and β -acetnaphthalide, benzanilide, and formanilide.

With formylphenylhydrazide, disodium formylphenylhydrazide is obtained. Benzamide yields a sodium compound of indefinite composition.

With propionanilide and butyranilide compounds similar to acetanilide sodium alcoholate appear to be formed in solution, but they could not be isolated. Sodium alcoholate does not react with diphenylacetamide and ethylacetanilide.

3. "Note on the electrolytic conductivity of formanilide and thioformanilide." By Thomas Ewan, B.Sc., Ph.D.

The majority of the amides are too little soluble in water to allow of measurements of electrolytic conductivity being made. Others, again, are decomposed by water too rapidly into acid and amine. The conductivity of formanilide shows that it possesses feebly acidic properties. In aqueous solution the sodium compound of formanilide is completely decomposed. In the case of thioformanilide, the sodium compound appears to exist in aqueous solution.

4. "The action of sugar on ammoniacal silver nitrate." By J. Henderson, B.Sc.

The author has investigated the reducing powers of the following substances on ammoniacal silver nitrate, viz., glucose, lævulose, galactose, cane-sugar, starch, dextrin, lactose, and maltose. The results obtained may be thus summarised:—

(1) When glucose, lævulose, and galactose are heated with ammoniacal silver nitrate under the given conditions, a definite factor can be found in each case.

(2) Cane-sugar, starch, and dextrin, when heated under the same conditions, exert no reducing action on ammoniacal silver nitrate.

(3) In the case of lactose and maltose a definite factor cannot be obtained, owing to the gradual hydrolysis of the disaccharide by the ammonia.

5. "Solution and diffusion of certain metals in mercury." By W. J. Humphreys.

The author has examined quantitatively the solution and diffusion of tin, lead, bismuth, zinc, copper, and silver in mercury with a view to determining the extent to which these phenomena differ, if at all, from the solution and diffusion of non-metallic solids in liquids. Pieces of metal were placed on the upper surface of a column of pure mercury, and samples of the liquid were taken at definite depths below the surface, and the amount of foreign metal estimated. As far as the experiments go, the author concludes that the solution and diffusion of metals in mercury do not essentially differ from those of non-metallic solids in liquids. Copper and silver dissolve in mercury to a very small extent at ordinary temperatures, but diffuse very rapidly.

6. "On some of the ethereal salts of active and inactive monobenzoyl, dibenzoyl, diphenylacetyl, and dipropionyl glyceric acids." By Percy Frankland, Ph.D., F.R.S., and John MacGregor, M.A.

The following compounds have been prepared by the authors:—

Methyl dibenzoylglycerate (active). Long radiating needles melting at 58—59°.

$$[\alpha]_D \text{ at } 183^\circ = +8.55^\circ; d \text{ } 183^\circ/4^\circ = 1.0951.$$

$$,, \quad 59.5^\circ = +22.13^\circ; d \text{ } 59.5^\circ/4^\circ = 1.1877.$$

$$,, \quad 15^\circ \text{ (calculated)} = +26.89^\circ.$$

Methyl dibenzoylglycerate (inactive). Long radiating needles melting at 44—46°.

Ethyl dibenzoylglycerate (active). Radiating needles melting at 25°.

$[\alpha]_D$ at 183°	$= +8.62^\circ$; $d\ 183^\circ/4^\circ = 1.0599.$
„ 16.5° (superfusion)	$= +26.28^\circ$; $d\ 16.5^\circ/4^\circ = 1.1996.$
„ 15° (calculated)	$= +26.58^\circ.$

Propyldibenzoylglycerate (active). Liquid boiling at $267\text{--}269^\circ$ under 11 mm. pressure.

$[\alpha]_D$ at 87°	$= +15.34^\circ$; $d\ 87^\circ/4^\circ = 1.1175.$
„ 19.5°	$= +20.71^\circ$; $d\ 19.5^\circ/4^\circ = 1.1771.$
„ 15° (calculated)	$= +21.00^\circ.$

Methyl diphenylacetyl-glycerate (active). Liquid boiling at $266\text{--}270^\circ$ under 17 mm.

$[\alpha]_D$ at 77.5°	$= -14.10^\circ$; $d\ 77.5^\circ/4^\circ = 1.1427.$
„ 14.5°	$= -16.06^\circ$; $d\ 14.5^\circ/4^\circ = 1.1972.$

Methyl monobenzoylglycerate (active). A dextro-rotatory liquid which, on distillation, yielded a more dextro-rotatory distillate. It is probable that the original liquid consisted of the α - and β -isomeric monobenzoylglycerates, of which the α -compound would have the lower boiling point, and that this α -compound is more dextro-rotatory than the β -compound.

Methyl monobenzoylglycerate (inactive). Crystallises in small, warty groups melting at $92.5\text{--}93^\circ$. It is probable that this is the β -compound, the α -compound being liquid.

Ethyl monobenzoylglycerate (active). Radiating needles melting at 62° . This is probably the β -compound; it is laevorotatory, whilst the liquid from which it crystallised, and which would contain the α -compound, was dextro-rotatory. This solid ethyl monobenzoylglycerate is remarkable for its almost complete insensitiveness to temperature, thus—

$[\alpha]_D$ at 136.5°	$= -9.47^\circ$; $d\ 136.5^\circ/4^\circ = 1.0886.$
„ 67°	$= -9.80^\circ$; $d\ 67^\circ/4^\circ = 1.1547.$

Methyl dipropionyl-glycerate (active). Liquid.

$[\alpha]_D$ at 15°	$= -10.97^\circ$; $d\ 15^\circ/4^\circ = 1.1349.$
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The relationship between the rotatory power and the chemical constitution of these and other derivatives of glyceric acid is discussed, attention being again directed to the manner in which the rotation is more powerfully influenced by the qualitative character than by the mere mass of the groups attached to the asymmetric carbon atom. It is also pointed out that the reaction is more influenced by an element or group of elements introduced in the vicinity than by the same at a distance from the asymmetric carbon atom.

7. "On the rotation of optically active compounds in organic solvents."
By Percy Frankland, Ph.D., F.R.S., and R. H. Pickard, B.Sc.

The authors have investigated the variation in the value of $[\alpha]_D$ for methyl dibenzoylglycerate when dissolved in benzene, nitrobenzene, ethylene dibromide, and acetic acid respectively, employing a number of different concentrations in the case of each solvent. The molecular weight was also cryoscopically determined for a series of similar concentrations with each solvent.

The cryoscopic determinations showed that inactive methyl dibenzoylglycerate does not exist as a "racemised" molecule in these solvents, practically the same values for the molecular weight being obtained as with the active compound under the same conditions.

The cryoscopic values were, with all the concentrations employed, below the theoretical ones in benzene; in ethylene dibromide and nitrobenzene they were below the theory with dilute, and above the theory with strong solutions. In the case of acetic acid, the cryoscopic values were with all concentrations sometimes above, and sometimes below, the theoretical value.

The values of $[\alpha]_D$ in the benzene solutions were much in excess, whilst in the nitrobenzene and ethylene dibromide solutions they were much below the value for $[\alpha]_D$ exhibited by the pure substance; in acetic acid the values for $[\alpha]_D$ most closely approximated to that of the pure substance. Low cryoscopic values for the molecular weight of methyl dibenzoylglycerate were accompanied by high values for $[\alpha]_D$, and *vice versâ*.

This relationship between $[\alpha]_D$ and indicated molecular weight is borne out by the behaviour of ethyl diacetylglycerate in benzene and acetic acid solutions respectively, only that in this case the low molecular weights and high specific rotations were obtained in acetic acid, the high molecular weights and low rotations in benzene solution.

The real value of $[\alpha]_D$ for an active body cannot be directly calculated from the rotation of its solution, even when the cryoscopic examination of that solution shows the molecular weight to be normal, and even a moderately accurate estimate of the real value of $[\alpha]_D$ can only be arrived at by the study of solutions giving normal molecular weights and extrapolating for infinite concentration on their rotation curves.

The explanation of these phenomena on the assumption of dissociation and association processes taking place in the several solutions, as has been suggested by Freundler, is discussed. The dissociation indicated by the low cryoscopic values obtained with methyl dibenzoylglycerate in benzene, and with ethyl diacetylglycerate

in acetic acid solution, appears to be in harmony with the rotation phenomena only if the dissociation consists in the splitting off of the methyl and ethyl groups respectively, the active ion retaining in each case the acid radicles (benzoyl and acetyl). This conclusion is opposed to that arrived at by Freundler in the case of the diacidyl tartrates.

8. "Note on the action of hydrogen chloride on ethyl alcohol." By J. C. Cain, B.Sc., Ph.D.

The author refers to the statement recently made by Dr. Armstrong, in his Presidential Address to the Society, that "Perkin has established the incorrectness of the supposition that until recently has always been made, that hydrogen chloride, when dissolved in alcohol, acts fairly readily on it," and points out that this supposition has been known to be incorrect for a considerable time.

Berthelot, in 1880, found that no reaction takes place on making the solution, and Villiers found a reaction at 10—25° only after some months. The author examined the action of hydrogen chloride on ethyl alcohol in 1893, and found that hydrogen chloride had no action on ethyl alcohol after acting for 17 days at 0° C., or for 15 days at 15° C. The reaction probably begins at 20—25° C.

A saturated solution of hydrogen chloride in alcohol contains 39.06 per cent. HCl, at 10° C. This is near the number found by Dr. W. H. Perkin, sen. (38.45 per cent.). The temperature at which the experiment was made is not given, and was therefore probably higher than 10° C.

9. "Transformation of the alkylammonium cyanates into the corresponding ureas." By J. Walker and J. R. Appleyard.

A comparison has been made of the rates of transformation of the alkylammonium cyanates into ureas, and of the reverse transformation of the ureas into cyanates. In every case the results agree with the assumption that the cyanates are present in the aqueous solution in the form of two independent ions. In some instances the reverse transformation is well developed; for example, equilibrium is reached in a 1/15 normal solution of tertiary amyl ammonium cyanate when half of the cyanate has been transformed into tertiary amyl urea, no production of the urea beyond that amount taking place. No definite relation between the values of the constants and the nature and number of the replacing alkyl groups was observed.

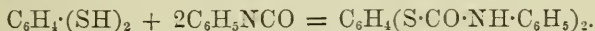
10. "On certain phenylthiocarbamates." By H. Lloyd Snape, D.Sc., Ph.D.

The author has examined the action of phenylthiocarbimide upon phenol, resorcinol, quinol, and glycol. A. E. Dixon (Trans., 57,

268) had already shown that interaction takes place between the above-named thiocarbimide and phenol; but his paper had been overlooked by the writer, who claims, in the course of the experiments he independently carried out, to have obtained the phenyl salt of phenylthiocarbamic acid in purer condition and in larger quantity. He found, in opposition to Dixon's experience, that the higher the temperature (below 280°) and the longer the duration of the experiment, the better was the yield, and in one experiment found this to amount to 25 per cent. of the theoretical, whereas Dixon, working at lower temperatures and for a shorter time, only obtained 7 per cent. By crystallisation from absolute alcohol, the crystals obtained melted sharply at 148° (149 — 151° , Dixon).

So much difficulty having been experienced in effecting combination between phenylthiocarbimide and phenol, it was to be anticipated that reaction between the former substance and dihydroxy-compounds would be even more difficult to carry out; and no thiocarbamate could be obtained from resorcinol, quinol, or glycol. The writer, however, succeeded in obtaining, by the action of phenyl cyanate upon dithioresorcinol and dithioquinol respectively, the isomerides of the thiocarbamates he had hoped to prepare by the foregoing method.

m-Phenylene Salt of Phenylene thiocarbamic acid.—Phenylcyanate and dithioresorcinol, in the theoretical proportions, were heated in a bath containing a solution of common salt for half an hour. Crystals rapidly separated. After washing with cold alcohol and recrystallisation from glacial acetic acid, large white needles were obtained melting at 178 — 179° . The reaction is expressed thus



p-Phenylene Salt of Phenylene thiocarbamic acid.—Phenylcyanate and dithioquinol was heated in a water bath. Again combination readily occurred. The crystals obtained by recrystallisation from glacial acetic acid were smaller than in the preceding case, and melted at 200 — 202° .

11. "The available potash in soils." By T. B. Wood, M.A.

The author has had under his care a number of experimental plots in Norfolk and Suffolk, and in this paper he tests the practicability of Dr. Bernard Dyer's method of estimating available potash in soils (Trans., 1894, 115—167), by comparing the analytical numbers obtained by Dr. Dyer's method with the results obtained in actual field experiment.

The soils experimented upon may be divided into two classes, viz., (I) those rich in available potash and (II) those poor in this sub-

stance. The former soils gave no marked crop increase (barley) when treated with potash manures, the latter gave a very large increase.

The former soils gave by Dr. Dyer's method on an average 0.0147 per cent. of available potash (sol. in 1 per cent. citric acid), the latter only 0.0073 per cent., whereas the potash soluble in strong hydrochloric acid (0.178 and 0.137) was much more nearly equal in each case.

The author concludes that Dr. Dyer's method is likely to be of technical value to the agriculturist; since, in the cases examined, laboratory experiments lead to the same conclusions as the more tedious and expensive field experiments. The modification of the method mentioned at the end of Dr. Dyer's paper for use in the case of soils containing much chalk gives far less satisfactory results than the unmodified analytical process.

ADDITIONS TO THE LIBRARY.

I. *Donations.*

Thorpe, T. E. A Manual of Inorganic Chemistry. Vol. I. The Non-metals. 511 pp. with 126 illustrations. Vol. II. The Metals. 430 pp. with 183 illustrations. London 1896. 8vo.

From the Author.

Thorpe, T. E. Quantitative Chemical Analysis. Tenth Edition. xiv+389 pp. with 88 illustrations. London 1893. 8vo. (Text-books of Science.)

From the Author.

Sadtler, S. P. A Handbook of Industrial Organic Chemistry adapted for the use of Manufacturers, Chemists, and all interested in the utilisation of Organic Materials in the Industrial Arts. Second revised and enlarged edition. xvi+537 pp. with 127 illustrations. Philadelphia 1895. 8vo.

From the Publishers.

Guttman, Oscar. The Manufacture of Explosives: a theoretical and practical treatise on the History, the Physical and Chemical Properties, and the Manufacture of Explosives. Vol. I. viii+348 pp. with 147 illustrations. Vol. II. xiv+444 pp. with 181 illustrations. London 1895. 8vo.

From the Author.

Pharmaceutical Society. The Calendar of the Pharmaceutical Society of Great Britain, 1896. 507 pp. London 1896. 8vo.

From the Society.

Landauer, John. Die Spectralanalyse: mit 44 in den Text eingedruckten Holzstichen und einer Spectraltafel. viii+174 pp. Braunschweig 1896. 8vo.

From the Publishers.

Roscoe, H. E., and Harden, Arthur. A new view of the Origin of Dalton's Atomic Theory: a contribution to Chemical History; together with letters and documents concerning the Life and Labours of John Dalton, now for the first time published from MS. in the possession of the Literary and Philosophical Society of Manchester. x+192 pp. with portrait. London 1896. 8vo.

From the Authors.

II. *By Purchase.*

Mémorial des Poudres et Saltpêtres. Publié par les soins du Service des Poudres et Saltpêtres avec l'approbation du Ministre de la Guerre. Tome VII. 233+154 pp. Paris 1894. 8vo.

Robinson, H. M., and Cribb, C. H. The Law and Chemistry of Food and Drugs. xx+499 pp. London 1895. 8vo.

Pamphlets.

The Discovery of Oxygen, and its immediate results, including the overthrow of the Phlogiston Theory. A concise account of the labours of Priestley, Scheele, Cavendish, and Lavoisier. 60 pp. London 1895. 8vo.

From the Author.

Seaman, W. H. On the relations of Chemistry to Education. Address of the retiring President before the Chemical Society of Washington, February 14, 1895. 45—63 pp. with a folding sheet. Washington 1895. 8vo.

(Reprint from Bull. No. 9 of the Chemical Society of Washington.)

From the Author.

Maiden, J. H., and Smith, H. G. Preliminary Notes on the Bark of *Carissa ovata*, R. Br. Var. *Stolonifera*, Bail.

(Reprint from Proc. Australian Association. Brisbane 1895.)

From the Author.

At the next meeting, on Thursday, February 6th, the following papers will be read:—

"The molecular weight and formula of phosphoric anhydride and of metaphosphoric acid." By Professor Tilden, F.R.S., and R. E. Barnett.

"Lead tetracetate and the plumbic salts." By Dr. A. Hutchinson and W. Pollard.

"An improved method of determining urea by the hypobromite process." By Alfred H. Allen.

CERTIFICATES OF CANDIDATES FOR ELECTION AT THE NEXT BALLOT.

N.B.—The names of those who sign from “General Knowledge” are printed in *italics*.

The following Candidates will be balloted for on Thursday, February 20, 1896 :—

Allan, John,

242, Moss Lane East, Manchester.

Analytical Chemist and Science Teacher. Seven years' experience in laboratory of Public Analyst. Six years Chemist in sugar refinery. Six years Teacher and Lecturer in Practical and Theoretical Chemistry.

John Wm. Biggart.

Angus Smith, F.I.C.

A. Humboldt Sexton.

Jas. Grant.

T. L. Patterson.

G. G. Henderson.

Barker, William Henry,

26, Belgrave Road, Longton, Staffs.

Lecturer in Chemistry, Technical Instruction, Endowed School, Longton, Staffs. B.Sc. London. Fourth in Honours Chemistry. Formerly Student at University College, Aberystwyth, and Owens, Manchester. Lecturer in Chemistry, Longton, Staffs.

H. B. Dixon.

W. H. Perkin, jun.

Arthur Harden.

P. J. Hartog.

Bevan Lean.

William A. Bone.

Bentley, William Henry,

110, Yarnburgh Street, Moss Side, Manchester.

Fellow of the Victoria University. Three years as Student in the Chemistry Department of Owens College. First Class Honours in Chemistry. B.Sc. Victoria. University Scholar and Dalton Scholar. Author of (1) “ $\beta\beta$ -Methylethylpropionic Acid” (*J. Chem. Soc.*, 1895); (2) “Methylisobutylacetic Acid” (*J. Chem. Soc.*, 1895).

Harold B. Dixon.

W. H. Perkin, jun.

J. F. Thorpe.

G. H. Bailey.

A. Harden.

Wm. A. Bone.

E. Haworth.

Blood, Maurice,

15, Clyde Road, Bristol.

Has taught and lectured in Chemistry and Mathematics during four terms at Northampton and County Modern and Technical School. Recently appointed to teach Chemistry and Physics at Kingston Endowed Schools. B.A. Oxford. Open Scholarship at Merton College, Oxford. During five years' residence obtained :— Second Class in Honour Mathematical Moderations. Second Class in Mathematics and Physics, Final Honour School. Second Class in Chemistry, Final Honour School.

R. Elliot Steel.

J. A. Gardner.

W. W. Fisher.

J. E. Marsh.

H. O. Hale.

Blyde, Joseph Edwin Alger,

Nether House, Ranmoor, Sheffield.

Steel Maker and Tester in the firm of Blyde, Ledingham and Company, the Wallace Steel Works, Sheffield, and Senior Partner in above firm. Maker of crucible steel and Member of Sheffield Metallurgical Society and Science Section of the Literary and Philosophical Society.

L. Archbutt.

Alfred H. Allen.

G. T. W. Newsholme.

Wm. Ward.

*William H. Oates.***Bowley, Joseph John,**

34, Elm Park Road, Chelsea.

Varnish and Colour Manufacturer, Wellington Works, Battersea. Manufacturer.

Willm. Thorp.

Boverton Redwood.

John Spiller.

Thos. Tyrer.

Frederic Jas. M. Page.

F. Napier Sutton.

*David Howard.**J. P. Formoy.***Bowman, Herbert Lister,**

13, Sheffield Gardens, Kensington, W.

Student in the University Laboratories, Oxford. B.A. Oxon. Honours in the Final School of Natural Science (Chemistry).

W. W. Fisher.

V. H. Veley.

John Watts.

William Odling.

D. H. Nagel.

T. C. Porter.

J. E. Marsh.

Bray, Daniel,

Broadmoor, Cinderford, Glos.

Manager and Chemist of the Broadmoor Chemical Works, Cinderford. Articled Pupil for three years to Dr. Wm. Morgan, F.I.C., late Public Analyst for County Borough of Swansea, &c. For two and three-quarter years Chemical Superintendent of the Wet Process for extraction of nickel and cobalt at H. H. Vivian and Co., Hafod Isha Works, Swansea. Now Manager of the Broadmoor Chemical Works, Cinderford, Glos.

Rhys P. Charles.

Sydney W. Harris.

*E. Grant Hooper.**Wm. Harkness.*

Arthur Luty.

W. Terrill.

*R. Bannister.**H. J. Helm.***Burbridge, James Kerry, A.I.C.,**

Moor's Lea, Winchmore Hill, N.

Works' Chemist. Studied at the University of Bonn for two Sessions, under Professors Kekulé, Anschütz, and Klinger. From 1890 to 1894 at King's College, London, in the Mathematical, Physical, and Chemical Departments. Have passed the Examination of the Institute of Chemistry, July, 1895. Have been engaged in chemical work connected with the manufacture of india-rubber goods during 1895.

John M. Thomson.

Patrick H. Kirkaldy.

H. S. Young.

Herbert Jackson.

Chas. A. Fawsitt.

*David Howard.***Candy, Hugh Charles Herbert,**

101, Gower Street, London, W.C.

Lecturer on Organic Chemistry at the London Hospital Medical School. Graduated B.A., Lond., 1883, and B.Sc., Lond., 1888, Student of Chemistry in Dr. Frankland's laboratory at the Normal School of Science, South Kensington, October, 1881—March, 1882, and of Chemistry and Physics, at University College, London, in 1883, and at intervals since.

E. Frankland.

Percy F. Frankland.

Frederic Jas. M. Page.

Hy. Forster Morley.

W. Palmer Wynne.

Percy A. B. Richards.

Craig, James,

6, Montague Street, Great Western Road, Glasgow.

Teacher. Master of Arts and Bachelor of Science of the University of Glasgow. Formerly Demonstrator in Chemistry in Veteri-

nary College, Glasgow, now Lecturer on Chemistry under Glasgow School Board, at Grove Street School.

G. G. Henderson.

A. Humboldt Sexton.

Percy F. Frankland.

John Ferguson.

R. R. Tatlock.

Horatio Ballantyne.

Edw. C. Stanford.

Dixon, Frank,

73, King Edward Road, S. Hackney, N.E.

Science Teacher. Royal College of Science, 1st Class Chem. Certificate, 1889. London University; Inter. B.Sc., 1894. Have taught Chemistry since 1890, and am at present teaching Chem. and Physics at Leman Street Foundation School.

Percy F. Frankland.

Samuel Jackson.

Lionel M. Jones.

Frederic Wm. Richardson.

A. E. Tutton.

Eiloart, Arnold,

2, Lausdowne Road, East Croydon.

Chemist. Assistant in Chemistry, Royal College of Science, South Kensington, formerly Instructor in Chemistry, Cornell University. Author of *A Guide to Stereochemistry*, &c.

William A. Tilden.

John M. Thomson.

Herbert Jackson.

Chapman Jones.

William Tate.

Ewan, Thomas,

The Yorkshire College, Leeds.

Demonstrator of Chemistry. B.Sc. (Vict.), Ph.D. (Munich), Demonstrator of Chemistry at the Yorkshire College, formerly 1851 Exhibition Scholar at Owens College. Author of a number of papers on Organic and Physical Chemistry, published in the *Transactions of the Chemical Society*, 1889 and 1892; *Philosophical Magazine*, 1892 and 1894; *Proceedings of the Royal Society*, 1895; *Liebig's Annalen*, 1895; *Zeitschrift für Physikalische Chemie*, 1894 and 1895; and elsewhere.

Arthur Smithells.

Harold B. Dixon.

W. H. Perkin, jun.

P. J. Hartog.

Herbert Ingle.

Julius B. Cohen.

G. H. Bailey.

Fuller, Charles James Pemeller,

Mona House, Horwich, Lancashire.

Analytical and Consulting Chemist. Have been engaged in Analytical Chemistry for the past 15 years, the last eight of which I

have been Chief Chemist at the Lancashire and Yorkshire Railway Company's Works at Horwich. Also Teacher of Inorganic Chemistry at the Horwich Technical School.

Edwd. Riley. Jno. L. Whiteside. E. H. Saniter.
R. Routledge. Jno. T. Brierley.

Grice, Walter Thomas,

9, Dalhousie Square, Calcutta.

Chemist to Messrs. Smith, Stainstreet, and Co., Manufacturing and Analytical Chemists. I have been engaged during the last six years in the analysis of raw materials, mineral products, and foods and drugs of this country, including:—Indigo, shellac, beeswax, cutch, bone dust, nitre, gold, lead, copper and tin ores, waters, milk, glue, butter, &c. Previous to this I was Assistant Chemist to Messrs. P. Harris, and Co., and afterwards in the laboratory of Mr. A. E. Robinson, F.C.S., in Birmingham.

Kanny Loll Dey. Preo Loll Dey. F. H. Alcock.
H. J. Shorthouse. C. J. H. Warden, M.D.

Harrington, William,

11, Edgehill, Whitehaven.

Chemist. Analyst. For four years Assistant to A. Kitchin, F.I.C. Have been for two years Teacher of Chemistry for the County Council of Cumberland, under the Whitehaven Technical Instruction Committee.

Archd. Kitchin. Robert Hellon.
George Dixon. D. A. Sutherland.
J. E. Brockbank.

Helps, James William,

3, Tavistock Road, Croydon.

Engineer and Manager to the Croydon Gas Company. Assoc. Mem. Inst. Civil Engineers. Studied Chemistry 1871-75, under Mr. J. W. Gatehouse, City Analyst, Bath. Carried out all chemical work for the Gas Department of the Leeds Corporation, 1876-1880, and since then for the Weston-super-Mare and Croydon Gas Companies, in my position as Engineer and Manager. When in Leeds I studied chemistry in Dr. Thorpe's evening classes, at the Yorkshire College of Science. Have designed and erected works for the manufacture of Sulphate of Ammonia, and have contributed papers on Gas Purification and Aniline Colours to several Associations.

Gerald T. Moody. Thomas G. Nicholson.
William J. Pope. H. Macan.
Henry E. Armstrong. F. Stauley Kipping.
Martin O. Foster.

Howard, Albert,

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Student of Chemistry in the Royal College of Science, London. First Class Honours in Chemistry at the Intermediate Science Examination of London University, and at the May Examinations of the Science and Art Department. At present taking the advanced course in Chemistry in the Royal College of Science, London.

William A. Tilden.

T. E. Thorpe.

W. Palmer Wynne.

Chapman Jones.

A. E. Tutton.

J. T. Hewitt.

J. W. Rodger.

*Thos. P. Blunt.***Jeffers, Ernest Haynes,**

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Assistant Chemist at Messrs. Garton, Hill and Company's Works, Battersea. Two years at evening classes in Chemistry, at People's Palace. Two years in Laboratory of Messrs. Gillman and Spencer. One and a half year's student in Chemistry at Royal College of Science, South Kensington.

Leonard Temple Thorne.

W. Palmer Wynne.

William A. Tilden.

J. W. Rodger.

*F. E. Matthews.***Johnstone, James,**

Braehead, Parkhill, Rutherglen.

Chemist. Fellow of the Institute of Chemistry. Chemist to Messrs. John and James White, Manufacturing Chemists, Sharsfield, Rutherglen, for 12 years. Previously Student and Assistant with Messrs. Wallace, Tatlock, and Clark, Public Analysts, Glasgow.

W. J. Chrystal.

Horatio Ballantyne.

John Clark.

W. T. Curphey.

George Watson.

Mathieson, Laurence W.,

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Teacher and Demonstrator of Chemistry in the People's Palace Technical Schools, E. Two sessions Junior Demonstrator in Chemistry to Professor Sexton, Glasgow, and West of Scotland Technical College, Glasgow. Two sessions Teacher of Chemistry in People's Palace Technical Schools, E. Honours (Practical and Theoretical) Science and Art Department, 1888 and 1892. Chemistry, Part I, 1st Class, Royal College of Science, London.

J. Theo. Hewitt.

T. E. Thorpe.

A. Humboldt Sexton.

*P. Hope Grant.**Edgar S. Barralet.*

Morrison, Joseph Edward,
Montreal.

Chemist. Chemist in charge of Laboratory of Messrs. Lyman, Sons and Co., Manufacturing Chemists. Editor *Montreal Pharmaceutical Journal*. Late Examiner in Chemistry for the Pharmaceutical Association of the Province of Quebec. Member Executive Board of the Montreal College of Pharmacy.

Alfred Hy. Mason.

Thomas Tyrer.

Joseph P. Remington.

Peter T. Austen.

J. H. Wainwright.

C. F. Chandler.

Robert L. Mond.

E. J. Millard.

Rostron, Harold,

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Assistant Schoolmaster. Bachelor of Science (Victoria), Chemistry and Physics. For four years a student of the Owens College, Manchester; in the Chemical (and Physical) Laboratories three years.

H. B. Dixon.

W. H. Perkin, jun.

P. J. Hartog.

Wm. A. Bone.

E. Haworth.

G. H. Bailey.

Gilbert J. Fowler.

Rutter, Thomas Francis,

The Huish School, Taunton.

Science Teacher. Scholar and Medallist of University College, London, Bachelor of Science, London University. Science Master, the Huish School, Taunton.

William Ramsay.

Morris W. Travers.

J. Norman Collie.

R. T. Plimpton.

H. R. Le Sueur.

Sage, Charles Edward,

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Chemist in Manufacturing Laboratory. For $2\frac{1}{2}$ years Assistant Analyst, for $1\frac{1}{2}$ years Chief Analyst, Works Laboratory. Pupil and Assistant for five years to Mr. T. A. Ellwood, F.I.C. Passed major examination of Pharmaceutical Society. Author of various papers on technical and analytical chemistry appearing under my name in *Pharmaceutical Journal* and other papers.

T. A. Ellwood.

Edward D. Gravill.

E. F. Harrison.

Hy. George F. Stacey.

G. Matthey.

John S. Selton.

Salt, Arthur Philip,

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Analytical Chemist. For two years student and Medallist in Chemistry (practical and theoretical) at the Polytechnic, London. Then for three years pupil, and now Assistant and Demonstrator to Professor J. Bayne, Analytical Chemist and Professor of Chemistry and Toxicology, Royal Veterinary College, London, N.W. Am Member of Society of Chemical Industry.

James Bayne.

Hubert E. Lindley.

Percy A. E. Richards.

Orestes V. Pisani.

Charles March Caines.

Bernard Dyer.

Scotland, Peter B.,

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Science Master, Secondary School, and Lecturer on Chemistry, Science and Art School, Airdrie. Three years pupil assistant under Professor J. R. Watson, M.A., Anderson's College, Glasgow. Four years as Demonstrator in Chemical Department, Coatbridge Technical School and Mining College. Two summer sessions at Royal College of Science. First Class Honours in Chemistry, Science and Art Department. Research on the Ferrocyanides and Ferriecyanides sensitive to light.

W. Palmer Wynne.

William Tate.

A. Humboldt Sexton.

William A. Tilden.

G. G. Henderson.

Simpson, Aitken Migget,

4, Kitto Road, St. Catherine's Park, S.E.

Laboratory Chemist. Twelve years Chemist in Laboratory at Messrs. Barrox, Harvey, and Co., 6, Gilsbur Street, E.C., manufacturing and analytical work. Study: Two years School of Arts, Edinburgh; certificates in Organic and Inorganic Chemistry; six years Finsbury Technical College, Evening Classes; certificate, Inorganic Chemistry.

R. Meldola.

Arthur Roes.

J. H. Robbins.

R. T. Marshall.

R. C. T. Evans.

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C. F. H. Warden, M.D.

Tarapusauna Roy.

Kanny Loll Dey.

Preo Loll Dey.

Ramchandra Dutta.

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Technological Museum, Sydney, New South Wales.

Research Assistant, and in charge of the Mineralogical and Geological Collections of the Technological Museum. Original papers before the Royal Society of New South Wales on Chemical and Mineralogical Subjects. Joint author with Mr. Maiden, the Superintendent of three researches in the domain of Organic Chemistry. Assistant in the investigation of very many products indigenous to the Colony, as Published in the Proceedings of various Societies.

J. H. Maiden.

A. Liversidge.

William M. Hamlet.

Edward H. Rennie.

John C. H. Mingaye.

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Henry E. Armstrong.

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Gerald T. Moody.

Holland Crompton.

F. Stanley Kipping.

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Analytical Chemist, Department of Health. Assistant Director, Municipal Laboratory. Superintendent Milk Inspection. Secretary, Section of Chemistry, Chicago Academy of Sciences. A Member of the American Chemical Society. Author of Papers on "Dust Explosions," "Chemistry Applied to Meat Packing, &c." Methods of Water Analysis and Methods of Milk Analysis. Report Chicago Department of Health, 1894.

M. H. Lachersteen.

Walter S. Haines.

PROCEEDINGS
OF THE
CHEMICAL SOCIETY.

EDITED BY THE SECRETARIES.

No. 160.

Session 1895-96.

January 23rd, 1896. EXTRA MEETING. Mr. A. G. Vernon Harcourt,
President, in the Chair.

Professor G. F. FITZGERALD, M.A., F.R.S., of Trinity College, Dublin, delivered the Helmholtz Memorial Lecture.

The position of the work of Helmholtz was considered with special reference to its chemical aspects, and the later work that had been grafted upon it. Some of the valuable points in the vortex atom hypothesis of matter were noticed, and some of its serious difficulties considered. Analogies on this hypothesis to the asymmetric carbon atom and to the benzene ring were pointed out. The applications of thermodynamics to chemistry were noticed, and a theoretically perfect, semi-permeable diaphragm for non-volatile salts in solution, in which the actions at all points are known, was described. The theory that a substance in solution is like a substance in the gaseous state was criticised, and it was contended that from Helmholtz's work, and on dynamical grounds, the conditions could not be alike. The theory that there was combination between the solvent and body in solution was put forward as a complete explanation of the known phenomena of solution and electrolysis. It was pointed out how Helmholtz had, by his work, made important steps forward in several directions towards a dynamical explanation of Nature.

DISCUSSION.

The PRESIDENT said that there were two ways in which we may do honour to a great fellow worker who has passed away. The one is by a rehearsal of the great things he had done; the other—and

perhaps this is rather that which the greatest would wish should happen after their own time has passed—is by a continuation of the lines of thought which they have started, and by following the work on which they have been engaged. Of the great variety of work which Helmholtz undertook—and there can scarcely be a greater scientific name than his, if the quality and variety of the work in which he engaged are taken into account—the lecturer this evening has naturally insisted on that side which Helmholtz himself selected as most appropriate when he was lecturing to this Society in the year 1881. These inquiries into the nature of molecules and other similar physical speculations which our lecturer this evening has touched upon, are of more recent growth. These are the problems which form our inheritance from that great man. Where work was so abundant there could scarcely be more than the enumeration of the great scientific results which we owe to Helmholtz. There are present this evening, besides many of our older members, several distinguished men of science who will say a few words on the subject of the lecture in proposing a vote of thanks to Professor Fitzgerald for the admirable exposition for which the Society is so much indebted to him.

Sir JOSEPH LISTER, P.R.S., said he had much pleasure in proposing a vote of thanks to Professor Fitzgerald for his profound and brilliant lecture. For his own part he felt himself in a world in which he was almost an entire stranger. These magnificent conceptions of physics must necessarily be nearly a *terra incognita* to the surgeon and physician. But physiologists and surgeons are deeply indebted to Helmholtz for what he did in their own domain. They recall with pride that Helmholtz was, in the first instance, a medical practitioner. It is an exceedingly remarkable fact in the case of such a profound and distinguished a physicist, that to the last he retained his love for his old subject, physiology. On this occasion it is not possible to allude to all that physiology owes to Helmholtz, but there are two questions to which reference might be made—his explanation of the accommodating power of the eye for different distances, and what has been for physiologists and ophthalmic surgeons—although Professor Fitzgerald regarded it as a mere triviality in Helmholtz's achievements—the great invention of the ophthalmoscope, that beautiful instrument by which the interior of the eye can be both illuminated and inspected. How much added to our knowledge of the physiology of the eye, and to the diagnosis of ophthalmic disease, and, consequently, to ophthalmic practice, and also to our knowledge of the various diseases which are found to be dependent upon or connected with affections of the eye—these discoveries, even if nothing else had been accomplished by Helmholtz,

would be enough to secure the gratitude of physiologists and surgeons.

Dr. EDWARD FRANKLAND said he had great pleasure in seconding the vote of thanks. He expressed the feeling of every Fellow of this Society in saying that Professor Fitzgerald had given an hour's discourse of enormous interest and importance to chemists. It would take some time to study and analyse this discourse, and to adequately discuss it in detail; but, whilst chemists had listened to the discussion of numerous points of contact of the work of Helmholtz with their own department of science, they were led anew to admire the intellect of that great man who left, perhaps, no branch of human knowledge untouched during his career. Professor Fitzgerald's references to the application of vortex motions to the explanation of the chemical combination and valency were somewhat discouraging, and there were one or two other sections of his discourse which he hoped and believed were slightly too pessimistic. We may hope that when another four or five decades have passed we shall arrive at a point when these physical theories which appear to us at the present moment almost impossible of application to chemical science will then appear perfectly clear; and when in this room, possibly, another Helmholtz is to be honoured in this way, we shall have the satisfaction of seeing these beautiful physical theories applied with effect to those obscure chemical phenomena on which we are all so anxious to have more light thrown.

Lord RAYLEIGH said that he might be allowed to add his congratulations to the Society on having secured Professor Fitzgerald to give this most interesting lecture upon certain aspects of the work of Helmholtz. He has done it in a way that few others, indeed if any other, could do it. It is to be hoped that chemists will take into grave consideration the emphatic warning that Professor Fitzgerald has given, particularly as to the danger of supposing that there is any dynamical similarity between the condition of a gas and that of a dissolved substance in a liquid. He quite agreed with much that had fallen from Professor Fitzgerald upon that subject. There is possibly a risk of pushing formal analogies too far, and of supposing that there is a real dynamical similarity, whereas there is, perhaps, only a similarity in mathematical law. Many of the ideas that he has broached required prolonged thought and study to do justice to them. The new idea of the construction of a semi-permeable membrane composed of minute capillary apertures in a fluid of non-wettable material seems likely to throw great light upon a rather obscure subject. He had long been impressed with the idea that capillarity is very closely connected with many of the problems which we should like to understand better than we do, leading, perhaps, almost into the recesses of

nature's chemical laboratory. His own familiarity with Helmholtz's work belonged to a different branch of the subject to that which Professor Fitzgerald had considered. Some thirty years ago he had studied with the ardour of youth Helmholtz's great work on the sensations of sound. Indeed, he had learned such German as he knew mainly from that book. It so happened that within the last year, in connexion with work of his own, he had been revising and consolidating his knowledge of that work, and he was quite as much impressed as he ever was with the extraordinary force and ability with which all the difficult problems that there arise are treated in turn by the distinguished author. Many of those who have written since upon the subject, and have criticised, perhaps too lightly, some of the positions assumed by Helmholtz—although, of course, no positions are to be considered as beyond criticism—seem to him not to be so familiar as they might be with the great work in which those positions were first of all set out. What Sir Joseph Lister and what Professor Frankland have said will be echoed by all who are acquainted with any side of Helmholtz's work, that everything that he touched was distinguished by his touch, and that there is scarcely any field of knowledge in which he has not, as it were, left his mark. All will agree that the object which the Society has had in view in commemorating the work of Helmholtz is a most excellent one, and that on this occasion it has been admirably attained.

Sir HENRY ROSCOE said that he could not say more than had been already said with regard to this lecture by Professor Fitzgerald, for which the Society was very grateful. He might add, perhaps, one personal reminiscence. He had the great honour and extreme pleasure, as President of the Society, of introducing Professor Helmholtz, in 1881, when he delivered the Faraday lecture here; and only a few months ago he happened to be at Heidelberg, and was speaking there to Professor Koenigsberger, the eminent mathematician, who was a very intimate scientific friend of Helmholtz. Koenigsberger spoke especially of Helmholtz's admiration, almost proceeding to reverence, for another great man who has passed away, whom we are glad to reckon amongst the greatest of our countrymen, Clerk Maxwell. Helmholtz used to talk of Clerk Maxwell and his work as almost supernatural. Koenigsberger thought that Maxwell was in many respects superior as a scientific physicist to Helmholtz himself. This shows that Helmholtz, in his magnanimity and high character, was the last to belittle the work of others.

Professor ARMSTRONG said he would like to recall a fact to memory—that probably Helmholtz's Faraday lecture was the one Faraday lecture which was distinctly an original contribution, which we can be sure exercised a very important influence on the scien-

tific world. A very large share of the attention which has been drawn to this subject of late years which van't Hoff, Arrhenius, and others have developed to such an extraordinary extent, has arisen out of that Faraday lecture by Helmholtz. Not only here but in Germany also it attracted very great attention, and was of very much consequence. To-night, again, the Society is to be congratulated very highly indeed that Professor Fitzgerald has most distinctly followed the example of the great man who gave the Faraday lecture in delivering a lecture of striking originality.

Professor POYNTING expressed his own gratitude and that of the other physicists present for the remarkable lecture to which they had had the privilege of listening.

The PRESIDENT said that there was one fact in respect to Helmholtz which had not been mentioned. Sir Henry Roscoe alluded to the fact of our own countryman, Clerk Maxwell, having been ranked on the same plane as Helmholtz as a physicist. Helmholtz himself was half an Englishman. It is always said that in the making of great men the mother's share is a large one; and the mother of Helmholtz was an English woman. She was a Miss Penn, and was connected with the same family as the founder of Pennsylvania.

The vote of thanks on being put to the meeting was carried by acclamation.

Professor FITZGERALD, in replying to the vote of thanks, said that he regarded it as a very great honour to be asked to deliver this lecture, and felt very much flattered indeed by the way in which it had been received. He would feel fully compensated for any trouble it had cost him if it helped his fellow workers and honoured Helmholtz. To help others with information was not so high an aim as to help them with moral ideals. The former was his aim; the latter was provided for him by the sympathy and encouragement of the Chemical Society. He thanked them for it.

February 6th, 1896. Mr. A. G. Vernon Harcourt, President, in the chair.

Mr. J. T. Dunn was formally admitted a Fellow of the Society.

Certificates were read for the first time in favour of Messrs. Sidney Barwise, The Lindens, Derby; Ernest Hunter Fisher, The County Laboratory, St. Albans; William Henry Merrett, Lambeth Brass and Iron Works, Short Street, Lambeth, S.E.; Joseph W. Patterson, Esq., Avenue Road, West Hartlepool; H. von Pechmann, Tübingen, Germany; James Proude, 13, Oak Terrace, Halifax; Henry Renney, M.D., B.Sc., D.P.H., Durham, Brookfield House,

Durham Road, Sunderland; Henry Fishwick Robinson, B.Sc., Sparthfield, Droylsden Road, Newton Heath, Manchester; John Henry Wolfenden, 226, Ashton Road, Failsworth, Manchester.

Of the following papers those marked * were read :—

- *12. "The molecular weight and formula of phosphoric anhydride and of metaphosphoric acid." By W. A. Tilden and R. E. Barnett.

The molecular formulæ As_4O_6 , Sb_4O_6 , P_4O_6 , $\text{P}_4\text{O}_6\text{S}_4$, and P_4S_6 , have been already established by determinations of the vapour densities of these compounds. The formula P_2O_4 has been assigned by Thorpe and Tutton to the compound they designate as phosphorus tetroxide, but no determination of the vapour density having been attempted it remains uncertain whether this formula truly expresses the molecular weight. The authors are of opinion that the low vapour density observed by V. and C. Meyer in the case of phosphoric sulphide is due to dissociation of that compound on vaporisation into phosphorus sulphide and sulphur.

They have made a series of determinations of the density of the vapour of phosphoric anhydride at a bright red heat with results which point to the formula P_4O_{10} , instead of the simpler expression P_2O_5 , which has always hitherto been accepted, chiefly on the ground of its assumed analogy with the pentasulphide.

They have also made determinations of the density of the vapour of metaphosphoric acid, from which they draw the conclusion that this compound is partly dissociated by heat into water and the anhydride, and that the acid must be represented by the molecular formula $\text{H}_2\text{P}_2\text{O}_6$.

DISCUSSION.

Mr. DAVID HOWARD remarked that distilled metaphosphoric acid had been known commercially.

Professor THORPE observed that in the course of his work with Mr. Tutton on phosphorous oxide, he had noticed the volatility of phosphorus pentoxide, but had not been able to make use of the property, owing to the readiness with which glass was attacked by the heated substance. He agreed with the authors in believing that phosphorus pentasulphide dissociates when it volatilises, and that on this account the molecular formula P_2S_5 was open to doubt. He also concurred as to the desirability of redetermining the formulæ of many of the metallic metaphosphates.

- *13. "Lead tetracetate and the plumbic salts." By A. Hutchinson, M.A., Ph.D., and W. Pollard, B.A., Ph.D.

In September, 1893, the authors communicated to the Society a short note on lead tetracetate (Trans., 63, 1136). Since that date

the work has been extended, and the detailed results are contained in the present paper.

Lead tetracetate is obtained when red lead is dissolved in glacial acetic acid, and crystallises from the solution in monosymmetric needles, $a : b : c = 0.5874 : 1 : 0.48485$. $\beta = 74^\circ 24'$.

The specific gravity of the crystals is 2.28; they are readily soluble in chloroform and hot acetic acid, and the molecular weight determined in the latter solvent is 365 by the boiling point method, and 408 by the freezing point method. Lead tetracetate is decomposed by water with extraordinary ease into lead dioxide and acetic acid; acted upon by gaseous hydrogen chloride it yields lead tetrachloride, whilst if dissolved in aqueous hydrogen chloride and the solution added to a solution of ammonium chloride, the double salt, $(\text{NH}_4)_2\text{PbCl}_6$, is precipitated. When acted upon by orthophosphoric acid, lead tetracetate yields a tetrphosphate, to which the formula $\text{Pb}(\text{HPO}_4)_2$ is probably to be assigned; a propionate, $\text{Pb}(\text{C}_3\text{H}_5\text{O}_2)_4$, analogous to the tetracetate, has been prepared.

The authors point out that thallic and manganic acetates, with properties very similar to those of lead tetracetate, have been described, and give a list of salts of tetravalent lead, owing to the close analogies which exist between the stannic salts and the salts of tetravalent lead. The authors propose that the latter should be termed plumbic salts.

***14 "An improved method of determining urea by the hypobromite process." By Alfred H. Allen.**

It is well known that in the ordinary way of employing the hypobromite process for the determination of urea the evolution of nitrogen in the form of gas is only about 92 per cent. of the total nitrogen present. An increased yield of nitrogen is obtainable by adding glucose, and by certain other devices, but these modifications are open to several objections, and have not met with general acceptance.

In a paper recently read before the Society (Trans., 67, 746) Messrs. Walker and Hambly described some suggestive experiments on the transformation of ammonium cyanate into urea. They find that the reaction is never complete, and they further point out that the reverse reaction occurs when an aqueous solution of urea is boiled. It follows that a solution containing both ammonium cyanate and urea ultimately arrives at a condition of equilibrium, which is upset if ammonium sulphate or potassium cyanate be added to the solution, the urea in each case being rendered more stable.

From these results it appeared probable that the incomplete evolution of nitrogen in the hypobromite process of determining urea

might be due to a reversion of a portion of the urea to the condition of cyanate, especially as H. J. H. Fenton had shown (Trans., 33, 309) that cyanate was a product of the reaction of alkaline hypochlorites on urea, and W. Foster (Trans., 35, 122) made the same observation with alkaline hypobromite. Fenton also found that cyanates evolved no gas when treated with alkaline hypobromite, and the author can confirm this observation. Hence it appeared possible that by adding a sufficiency of potassium cyanate to the urea solution before adding the hypobromite the reversion of the urea to cyanate might be entirely prevented. Experiment has proved this conjecture to be correct. An addition of 0.250 gram of pure potassium cyanate to the solution of 0.100 gram of urea in 5 c.c. of water raised the evolved nitrogen from 91 to nearly 97 per cent. (corr.)

If the ordinary method of operating be reversed, and instead of adding the urea solution (mixed with potassium cyanate) to a highly alkaline solution of sodium hypobromite, the cyanate be added to the solution of urea, followed by caustic soda when its solution is complete, and the bromine solution be then gradually run in, still better results are obtained. Under these conditions the yield of nitrogen is from 99.8 to 100.0 per cent. (corr.). Hence the addition of potassium cyanate to the extent of two to three times the weight of the urea present effects a complete evolution of the nitrogen in the form of gas, and prevents the irregularities and uncertainty attaching to the hypobromite process in its ordinary form.

The idea of reversing the usual mode of procedure appears to have originated with J. R. Duggan (*Amer. Chem. J.*, 4, 47), who states that fully 99 per cent. of the ureal nitrogen is evolved as gas if 5 c.c. of urine be first mixed with 20 c.c. of a solution of 20 grams of caustic soda in 100 c.c. of water, and 1 c.c. of bromine be gradually added. I have not been able to obtain so high a yield as 99 per cent. of gas without the addition of potassium cyanate, but the reversed process is in any case a valuable improvement on the ordinary method of working.

A convenient arrangement for the reversed form of the process is found in the author's work on the "Chemistry of Urine." In this apparatus a separatory funnel is substituted for the sample-tube generally used. Five c.c. of the urine or other solution of urea should be placed in the flask, and 0.250 gram of potassium cyanate added. When solution is complete, 25 c.c. of a 40 per cent. aqueous solution of caustic soda is added, the separator adjusted, and the flask connected to the nitrometer. A solution of 2 c.c. of bromine in 16 c.c. of a 20 per cent. aqueous solution of potassium bromide is then added gradually from the tapped separator. The evolution of

nitrogen occurs very promptly, and is usually complete by the time one-half of the prescribed volume of bromine solution has been added.

The use of silver cyanate, with or without simultaneous addition of sodium chloride, was found less satisfactory than the addition of the potassium salt.

It appeared probable that the reaction of the alkaline hypobromite with potassium cyanide would result in the formation of cyanate, in which case potassium cyanate could be conveniently extemporised in the liquid. Experiment showed that on adding potassium cyanide to the alkaline hypobromite great evolution of heat occurred, cyanate is formed, but the reaction appears to be complex, and the product had not the same effect as previously prepared potassium cyanate. The author intends to investigate this reaction more completely, as it does not appear to have been previously studied.

DISCUSSION.

Mr. FENTON made an experiment to show that when sodium hypochlorite reacts with urea the quantity of nitrogen evolved is only one-half of that obtained by the action of hypobromite. He had been unable to find an entirely satisfactory explanation of the fact.

Professor THORPE pointed out that Lord Rayleigh had stated that the gas evolved by the reaction of urea with alkaline hypobromite was not pure nitrogen, and suggested the desirability of examining the gas more fully.

Professor TILDEN concurred in regarding this as an important point.

Mr. HEHNER thought Mr. Allen's modified method of using this alkaline hypobromite would prove of value. He did not consider, however, that the mode of action of the potassium cyanate had been completely explained.

Mr. GROVES and Mr. PAGE remarked that the simplicity and rapidity of the hypobromite method was a strong recommendation from the clinical point of view, and Mr. PAGE pointed out that the employment of free bromine, which is required for the "reversed" process, would be a disadvantage in the wards of a hospital.

Mr. CROSS thought it would be of interest in connection with the anomalous behaviour of urea to mention that he had observed that whilst a mixture of sulphuric acid and potassium dichromate failed to cause the evolution of nitrogen from urea, this gas is plentifully evolved if a nitrate is added to the mixture.

*15. "Preliminary note on the absorption of moisture by deliquescent salts." By H. Wilson Hake, Ph.D.

Some years ago the author, in experimenting with deliquescent

A.	B.	C.	D.	E.	F.	G.	H.
Substance.	Original hydration per cent.	Maximum hydration per cent. reached.	Nearest molecular formula corresponding to C.	Theoretical hydration per cent. corresponding to D.	Difference between theoretical and found hydration per cent.	Theoretical difference per cent. for 1 mol. H ₂ O more than D.	Theoretical difference per cent. for 1 mol. H ₂ O less than D.
MgCl ₂ ·6H ₂ O	53·20	77·20	MgCl ₂ ·18H ₂ O	77·33	-0·13	+0·93	-1·02
Mg(NO ₃) ₂ ·4H ₂ O	18·18	65·89	Mg(NO ₃) ₂ ·16H ₂ O	66·05	-9·16	+1·35	-1·46
CaCl ₂ ·6H ₂ O	49·31	73·24	CaCl ₂ ·17H ₂ O	73·38	-0·14	+1·10	-1·20
Fe ₂ Cl ₆ ·12H ₂ O	39·92	66·52	Fe ₂ Cl ₆ ·36H ₂ O	66·59	-0·07	+0·61	-0·63
NiCl ₂ ·6H ₂ O	45·38	70·03	NiCl ₂ ·17H ₂ O	70·18	-0·15	+1·18	-1·28
Mn(NO ₃) ₂ ·3H ₂ O	23·17	61·54	Mn(NO ₃) ₂ ·16H ₂ O	61·67	-0·13	+1·42	-1·54
H ₂ PtCl ₆ ·6H ₂ O	20·85	47·82	H ₂ PtCl ₆ ·21H ₂ O	47·97	-0·15	+1·16	-1·22
H ₂ SO ₄	4·20	64·63	H ₂ SO ₄ ·10H ₂ O	64·74	-0·11	+2·15	-2·43
LiCl	0·00	77·40	LiCl·8H ₂ O	77·21	+0·19	+2·00	-2·44

salts, found that they exerted a desiccating action on other deliquescent salts, indicating a difference in the degree of attraction for moisture on the part of such salts.

More recently experiments were commenced with the intention of measuring, if possible, the relative degree of deliquescence, or specific deliquescence, of certain salts.

On exposing known quantities to the air, and weighing them at frequent intervals, in all cases, without exception, a maximum of deliquescence was reached in a few days, and from this point a gradual decline in weight almost invariably followed.

This maximum coincides with the formation of a definite hydrate, in a large number of cases, when the salt was pure; the water contained in it at its maximum of deliquescence approximately coincides with that required for a definite number of water molecules. As in all such cases, there was a possible margin of 1 per cent. and over for the next one molecule more or less of water, the author concludes that the phenomenon of deliquescence in certain salts, and possibly other substances, is due to a tendency on their part to form a definite hydrate.

The table on page 34 indicates some of the results obtained at present.

The above salts were found to be practically pure on analysis; with less pure salts an approximation to a definite hydrate was obtained, but in most cases this was sufficiently close to indicate the probable truth of the hydrate assumption.

DISCUSSION.

The PRESIDENT, Professor E. W. MORLEY, and Professor DUNSTAN commented on the fact that Dr. Hake had not so far studied the relation of the amount of absorption to the vapour pressure of water in the atmosphere to which the salts were exposed, and pointed out that until this had been done no positive conclusion could be drawn from the results.

16. "Some derivatives of γ -phenoxyethylmalonic acid and of γ -phenoxyethylacetic acid." By W. H. Bentley, E. Haworth, and W. H. Perkin, junr.

γ -Phenoxyethylmalonic acid, $C_6H_5O \cdot CH_2 \cdot CH_2 \cdot CH(COOH)_2$, is easily prepared by the action of $C_6H_5O \cdot CH_2 \cdot CH_2Br$, β -bromomethylphenyl ether, on ethylic sodiomalonate, and the hydrolysis of the resulting ethereal salt with potash. It crystallises from xylene in minute needles melting at 142° with slight evolution of gas.

γ -Phenoxybutyric acid $C_6H_5O \cdot CH_2 \cdot CH_2 \cdot CH_2 \cdot COOH$, *γ -phenoxyethylacetic acid*, is obtained by heating *γ -phenoxyethylmalonic acid* to

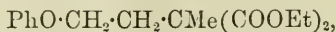
160—200° until the evolution of carbon dioxide ceases. It separates from light petroleum in thin plates melting at 64—65°. Heated with fuming hydrobromic acid it loses phenol, forming a bromo-derivative, which, on boiling with sodium carbonate and acidifying the product, yields butyrolactone.

Diphenoxyethylmalonic acid, $(\text{C}_6\text{H}_5\cdot\text{O}\cdot\text{CH}_2\cdot\text{CH}_2)_2\text{C}(\text{COOH})_2$, is obtained by acting on ethylic malonate twice with sodium and β -bromethylphenyl ether, and subsequent hydrolysis of the product with potash. It crystallises from 50 per cent. acetic acid in prisms melting at 150° with decomposition.

Diphenoxyethylacetic acid, $(\text{C}_6\text{H}_5\cdot\text{OCH}_2\cdot\text{CH}_2)_2\cdot\text{CH}\cdot\text{COOH}$, is prepared by heating diphenoxyethylmalonic acid at 180° until carbon dioxide ceases to be evolved. It separates from light petroleum in needles melting at 88°.

α -*Phenoxyethyl- γ -hydroxybutyric acid*, $\text{C}_6\text{H}_5\cdot\text{O}\cdot\text{CH}_2\cdot\text{CH}_2 > \text{CH}\cdot\text{COOH}$, results on heating diphenoxyethylacetic acid with hydrogen chloride, dissolved in acetic acid for some hours at 130°. It crystallises from benzene in plates melting at 112°, and is very sparingly soluble in ether.

Ethylic- γ -phenoxyethyl- α -methyl malonate,



is prepared by the action of $\text{C}_6\text{H}_5\cdot\text{O}\cdot\text{CH}_2\cdot\text{CH}_2\cdot\text{Br}$ on the sodium compound of ethylic methyl malonate. It is a thick, colourless oil (b. p. 230°, pressure 45 mm.), which, on hydrolysis, gives the corresponding dibasic acid γ -*phenoxyethyl- α -methylmalonic acid*. This acid crystallises from benzene in colourless prisms, which melt at 125° C.

γ -*Phenoxyethyl- α -methylacetic acid* is obtained by heating the previous acid at 180° till evolution of CO_2 ceases, and then distilling in a vacuum (b. p., 207°, pressure, 45 mm.). Recrystallised from light petroleum, the acid melts at 80°. This acid was also obtained by the action of β -bromethylphenyl ether on the sodium compound of ethylic methylacetate, and saponifying the resulting ether (a colourless syrup, b. p. 185°, pressure 40 mm.) with strong alcoholic potash.

α -*Methylbutyrolactone* was obtained from the previous acid by first treating with aqueous hydrobromic acid, and then boiling the resulting bromo-acid with sodium carbonate solution.

The lactone was then reconverted into γ -bromethyl- α -methylacetic acid by treatment with HBr . This acid, which is very unstable, is a brownish, oily substance; its ethyl ether is also unstable, and could not be distilled. γ -Chlorethyl- α -methyl acetyl chloride was obtained

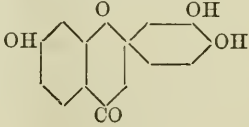
as a colourless liquid (b. p. 189°) by the action of phosphorus pentachloride on α -methylbutyrolactone. This chloride, when acted on by aniline, gave an anilide, $\text{ClCH}_2\cdot\text{CH}_2\cdot\underset{\text{CH}_3}{\text{CH}}\cdot\text{CONH}\cdot\text{C}_6\text{H}_5$, which crystallises from light petroleum in colourless prisms (m. p. 106°).

17. "Note on the preparation of glycol." By E. Haworth and W. H. Perkin, jun.

This paper describes a modification of the usual method of preparation of glycol, which consists in decomposing in a given volume of aqueous potassium carbonate, successive quantities of ethylene dibromide, by which means a concentrated solution of glycol is obtained, and subsequent loss by evaporation is reduced to a minimum.

18. "Luteolin." By A. G. Perkin.

Luteolin, the yellow colouring matter of Weld (*Reseda luteola*), was first isolated by Chevreul (*J. Chim. Méd.*, 6, 157), and has been subsequently investigated by others. The formula $\text{C}_{20}\text{H}_{14}\text{O}_6$ was assigned to it by Moldenhauer, $\text{C}_{12}\text{H}_8\text{O}_5$ by Schützenberger and Paraf, and $\text{C}_{15}\text{H}_{10}\text{O}_6$ by Hlasiwetz and Pfaundler. The results here obtained agree with $\text{C}_{20}\text{H}_{14}\text{O}_6$ and $\text{C}_{15}\text{H}_{10}\text{O}_6$, and that the latter is correct is proved by the production of various derivatives. In a similar manner to quercetin, fisetin, and morin (*Trans.*, 1895, 644), luteolin combines with mineral acids, yielding the crystalline compounds $\text{C}_{15}\text{H}_{10}\text{O}_6\text{H}_2\text{SO}_4$, $\text{C}_{15}\text{H}_{10}\text{O}_6\text{HBr}\cdot\text{H}_2\text{O}$ and $\text{C}_{15}\text{H}_{10}\text{O}_6\text{HCl}\cdot\text{H}_2\text{O}$, which, in contact with water, are decomposed into luteolin and the free acid. Luteolin yields a tetracetyl compound, $\text{C}_{15}\text{H}_6\text{O}_6(\text{C}_2\text{H}_3\text{O})_4$, colourless needles, m. p. 213—215°, a tetrabenzoyl compound $\text{C}_{15}\text{H}_6\text{O}_6(\text{C}_7\text{H}_5\text{O})_4$, m. p. 200—201°, and a dibromo-compound, $\text{C}_{15}\text{H}_8\text{Br}_2\text{O}_6$, yellow needles, m. p. 303°. The acetyl compound of this latter, $\text{C}_{15}\text{H}_4\text{Br}_2\text{O}_6(\text{C}_2\text{H}_3\text{O})_4$, melts at 218—220°. Rochleder has previously found that luteolin, by fusion with alkali, yields phlorogiucin and protocathechuic acid, but preliminary experiments have shown that though the former is so produced, the presence of the latter could not be detected. There was, however, isolated a second substance in the form of nearly colourless needles, melting at 210°, but giving no coloration with ferric chloride. On methylation, luteolin yields a compound of the formula $\text{C}_{15}\text{H}_6\text{O}_6(\text{CH}_3)_4$, m. p. 191—192. It is considered probable that luteolin is very similarly constituted to fisetin, $\text{C}_{15}\text{H}_{10}\text{O}_6$, or tetrahydroxy- β -phenyl- γ -

pyron, Herzig (*Ber.*, 1895, 28, 293), , which it

very closely resembles.

19. "An examination of the products obtained by the dry distillation of bran with lime." By W. F. Laycock, Ph.D.

Considerable quantities of bran and unslaked lime, in the proportions of 1:2 by weight, were subjected to dry distillation. The resulting distillate consisted of a black oil floating on an aqueous solution. The solution contained considerable quantities of ammonia, chiefly as bicarbonate also amines and pyrrols, together with small amounts of ketones, and ethyl alcohol.

The oil after redistilling was treated with dilute hydrochloric acid and the pyridine bases thus separated were afterwards purified. The unchanged oil was freed from small amounts of ketones by shaking with sodium bisulphite solution. The residual oil consisted of a mixture of hydrocarbons and pyrrol homologues with small quantities of furfuranes and an indole.

20. "Constitution of glycocine." By Jōji Sakurai.

Since the publication of my paper on the "Constitution of glycocine and its derivatives," (Proc. 137), important facts have been contributed to the history of the subject by eminent authorities, and it is interesting to observe that these new facts are either confirmatory of the ring constitution or, at least, in conformity with it.

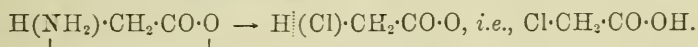
Walker (Proc., 137) has made the very important observation that glycocine is virtually a non-conductor of electricity, whilst phenyl-glycocine, hippuric acid, and aceturic acid are far better conductors than acetic acid, and has concluded that these glycocine derivatives must be open-chain compounds and that, by analogy, glycocine itself has not the ring constitution. But if electric conductivity of glycocines proves anything as to their constitution it must be concluded, by the very same reasoning that glycocine itself, being a non-conductor, cannot be an open-chain compound. A probable explanation of the difference in the electric conductivities of glycocine and its derivatives, which gives every support to the view of the cyclic constitution of the glycocines seems obvious to me. It is that while glycocine itself appears not to form an addition compound when dissolved and, consequently, could undergo no ionisation, its derivatives do form such addition compounds, these being, as pointed out in my paper, open-chain compounds and, therefore, capable of more or less ionisation. Betaine is an example in point which, in the anhydrous and hydrated states, is, by universal admission, $\text{N}(\text{CH}_3)_3 \cdot \text{CH}_2 \cdot \text{CO} \cdot \text{O}$ and $\text{HO} \cdot \text{N}(\text{CH}_3)_3 \cdot \text{CH}_2 \cdot \text{CO} \cdot \text{OH}$, respectively.

Tilden and Forster (Trans., 67, 489; Proc., 151) find that the

primary action of nitrosyl chloride upon glycocine and several of the acid-amides is to replace the NH_2 -group by Cl , glycocine, in this manner, producing chloracetic acid. This fact they consider to be at variance with the ring formula of glycocine. The difficulty, however, does not exist. There being, as they say, complete removal of the NH_3 -group by NOCl with formation of $\text{N}_2\text{H}_2\text{O}$, and HCl , the remaining group will be $\text{CH}_2\cdot\text{CO}\cdot\text{O}$, and this, like ethylene oxide, will

almost inevitably combine with hydrogen chloride, and produce chloracetic acid. This explanation is in conformity with that which Tilden and Forster give of the production of acetic acid from acetamide, where they assume that acetyl chloride is first formed, and then acted upon by water.

The ring formula of glycocine gives yet another explanation of the formation of chloracetic acid, and again from Tilden and Forster's standpoint. Admitting, as they say, that by the action of nitrosyl chloride there is an interchange between NH_2 and Cl , of the divalent group, NH_3 , there will H left along with the Cl , but hydrogen and chlorine being both monovalent, the H will go to the half-freed O , so as to give rise to chloracetic acid.



These two explanations of the production of chloracetic acid from glycocine differ only in assuming or not that hydrochloric acid has a temporary existence apart from the rest of the elements prior to the formation of chloracetic acid.

A full account of the facts supporting the theory that the glycocines are closed chain compounds is contained in the *Journal of the College of Science, Imp. Univ., Japan*.

ADDITIONS TO THE LIBRARY.

I. By Purchase.

Boltzmann, L. Vorlesungen über Gastheorie. Theil I. Theorie der Gase mit Einatomigen molekülen, deren Dimensionen gegen die mittlere Weglänge verschwinden. viii+204 pp. Leipzig 1895. 8vo.

Maxwell, T. C. Ueber Faraday's Kraftlinien. 130 pp. Leipzig 1895. 8vo.

(Ostwald's Klassiker der Exakten Wissenschaften. 69.)

Meyer, L., und Mendelejeff. Das Natürliche System der Chemischen Elementes. 134 pp., with a Table. Leipzig 1895. 8vo.

(Ostwald's Klassiker der Exakten Wissenschaften. 68.)

Seebeck, T. J. *Magnetische Polarisation der Metalle und Erze durch Temperatur-Differenz.* 120 pp. Leipzig 1895. 8vo.

(Ostwald's *Klassiker der Exakten Wissenschaften.* 70.)

Rideal, S. *An Introduction to the Study of Disinfection and Disinfectants, together with an account of the chemical substances used as antiseptics and preservatives.* With 19 figures and a folding plate. xii+328 pp. London 1895. 8vo.

Carpenter, W. L., and Leask, H. *A Treatise on the Manufacture of Soap and Candles, lubricants and glycerin.* Second edition, revised and enlarged. With 104 figures. xii+446 pp. London 1895. 8vo.

II. *Donations.*

Pelouze, J., and Fremy, E. *Abrégé de Chimie.* Deuxième édition. Partie I. Notions préliminaires et Métalloïdes, avec 5 planches. Partie II. Métaux et Métallurgie, avec 1 planche. Partie III. Chimie Organique, avec 1 planche. 638 + 332 pp. Paris 1853. 8vo.

From B. H. Brough, Esq.

Nicholson, William. *The First Principles of Chemistry.* Second edition, with improvements. 560 pp. London 1792. 8vo.

From B. H. Brough, Esq.

Meyer, Dr. Lothar. *Die Atome u. ihre Eigenschaften.* Sechste Auflage. xviii+171 pp. With a diagram. (*Die Modernen Theorien der Chemie u. ihre Bedeutung für die Chemische Mechanik i. Erstes Buch*). 8vo.

From the Publishers.

Catalogue of Scientific Papers (1874--1883). Compiled by the Royal Society of London. Vol. XI. (Pet—Zyb). 902 pp. London 1896. 4to.

From the Royal Society.

At the next meeting on Thursday, February 20th, there will be a ballot for the election of Fellows, and the following papers will be read:—

“The origin of colour; the yellow 2 : 3-hydroxynaphthoic acid.”

“Note on etherification.”

“The relation of pineue to citrene.” By Prof. Armstrong, F.R.S.

PROCEEDINGS

OF THE

CHEMICAL SOCIETY.

EDITED BY THE SECRETARIES.

No. 161.

Session 1895-96.

February 20th, 1896. Mr. A. G. Vernon Harcourt, President, in the chair.

Messrs. Jervis E. Foakes and C. E. Harrison were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. Henry Thomas Durant, *c/o* Messrs. Loewenstein and Co., Johannesburg, South Africa; Herbert Edwin Macadam, Adam's Chemical Co., Victoria Docks, E.; Charles H. Reissman, B.A., B.Sc., Saxony Villa, Oppidans Road, Primrose Hill, N.W.; James Edward Shum Tuckett, M.A., 14, Hyde Road, Eastbourne.

It was announced that the following changes in the Officers and Council were proposed by the Council:—

As *Vice-Presidents*: Professor James Dewar, F.R.S., and Professor W. A. Tilden, F.R.S., *vice* Dr. E. Atkinson and Mr. C. O'Sullivan, F.R.S.

As *Ordinary Members of Council*: Dr. Forster Morley, Dr. G. H. Morris, Mr. J. W. Rodger, and Professor Arthur Smithells, *vice* Professor H. Dixon, F.R.S., Mr. R. J. Friswell, Dr. Kipping, and Dr. W. P. Wynne.

Messrs. Bertram Blount, H. Brereton Baker, and Dr. J. Shields were appointed to audit the Society's accounts.

The following were duly elected Fellows of the Society.

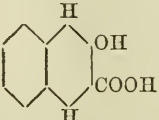
John Allan, William Henry Barker, B.Sc., William Henry Bentley, B.Sc., Maurice Blood, B.A., Joseph Edwin Alger Blyde, Joseph John Bowley, Herbert Lister Bowman, B.A., Daniel Bray, James Kerry Burbridge, Hugh Charles Herbert Candy, B.Sc., James Craig, M.A.,

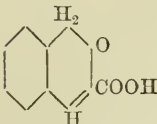
B.Sc., Frank Dixon, Arnold Eiloart, Ph.D., Thomas Ewan, B.Sc., Ph.D., Charles James Pemmeller Fuller, Walter Thomas Grise, William Harrington, James William Helps, Albert Howard, Ernest Haynes Jeffers, James Johnstone, Cass L. Kennicott, Laurence W. Mathieson, Joseph Edward Morrison, Harold Rostron, B.Sc., Thomas Francis Rutter, B.Sc., Charles Edward Sage, Arthur Philip Salt, Peter B. Scotland, Aitken Migget Simpson, Amrita Lal Sircar, L.M.S., Henry George Smith, Benjamin Bernard Turner, B.Sc.

Of the following papers those marked * were read:—

- *21. "The origin of colour. No. XI. The yellow colour of 2 : 3-hydroxynaphthoic acid." By Henry E. Armstrong.

Möhlau, in a recent most interesting note (*Ber.*, 1895, 3100), draws attention to the remarkable fact that 2 : 3-hydroxynaphthoic acid and a number of its derivatives are coloured (yellow) substances. On account of this peculiarity, he proposes to substitute for the

conventional formula , the isodynamic expression

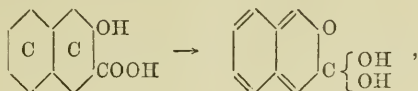
, and seeks to explain the fact that the ethylic salt

of the acid dissolves in alkali, yielding a yellow solution, by the assumption that a yellow sodium derivative is produced by the displacement of one of the two hydrogen atoms in position 1.

These new formulæ do not seem to harmonise with any conception which can at present be formed as to the interrelationship of colour and structure, a subject to which the present writer has so often directed attention in communications to the Society (compare *Proc.*, 1890-93). It is not difficult, however, to account for the appearance of colour in such a case by an assumption similar to that already made use of by him in the case of certain terephthalic and other benzenoid compounds, as well as of certain quinoline derivatives (*Proc.*, 1892, 103 ; 1893, 13, 52, 55, 206 ; *Trans.*, 1892, 789).

Whatever the exact structure of naphthalene may be, it is presumably centric in form, and not ethenoid, although its great activity in comparison with that of benzene may be regarded as evidence of a strong tendency to change its form. If it be supposed that, owing to the strong tendency which oxygen exhibits in so many benzenoid compounds to assume the keto-form, 2 : 3-hydroxynaphthoic acid can

pass from the hydroxy- to the isodynamic keto-form, and in so doing affect the structure of the cycloid itself, in the manner shown by the following symbols,



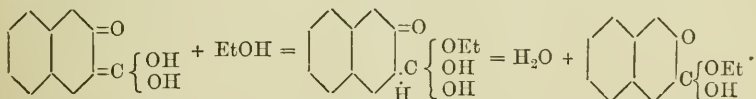
the yellow colour is accounted for without difficulty, as such a compound would be not only an orthoquinonoid derivative of naphthalene, but also an orthoquinonoid derivative of benzene. The "ethereal salt" of such an acid would contain a free hydroxyl group, and might therefore well be acid.

The behaviour of the acid with phenylhydrazine, to which Schöpf has just drawn attention (*Ber.*, 1896, 255), is without difficulty expressed by the formula here suggested.

***22. "Note on etherification." By Henry E. Armstrong.**

Möhlau, in the paper referred to in the foregoing note, calls attention to V. Meyer's observation that the 2 : 3-acid in question is converted into an ethylic salt more readily than is the isomeric α -hydroxynaphthoic acid, and regards this as strong evidence in favour of his view of the constitution of the acid.

An acid represented by a formula such as is suggested above would probably be particularly prone to combine with an alcohol, thus



Attention is now drawn to this with the object of raising the question whether some such explanation may not apply to the remarkable generalisation at which V. Meyer has arrived in the case of diortho-substituted acids, and which he has sought to justify by introducing space considerations.

The formation of a salt is presumably preceded by that of a combination of acid and "alkaloid," from which water is then eliminated. Just as the acid-attracting power of the NH_2 radicle in aniline is affected by the introduction, say, of chlorine, so, in like manner, the "alkaloid" attracting power of the carboxyl group may be assumed to vary as radicles are introduced in its neighbourhood in place of hydrogen—more particularly in the case of benzenoid compounds.

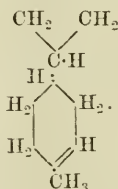
Apparently such effects are not sufficiently taken into account—the observations on the dimethylanilinesulphonic acids made in the writer's laboratory by Miss Evans (compare *Proc.*, 1895, 235), may be referred to as of considerable interest from this point of view,

showing as they do that the mere introduction of two methyl groups into the NH_2 -group in place of the hydrogen altogether modifies the character of the compound, rendering it insensitive to the action of bromine in a most remarkable manner. It is intended to make experiments to ascertain if the introduction of different alkyls into the carboxyl group affect the behaviour of acids in any similar manner.

*23. "The relation of pinene to citrene." By Henry E. Armstrong.

A. v. Baeyer in his recent (13th) note on orientation in the terpene series, shows in a most interesting manner that the genetic connection existing between pinene and citrene is far closer than has hitherto been supposed. It may, therefore, be desirable to briefly put on record an idea with reference to pinene which has long been in the writer's mind, and which has led him to regard the problem of its constitution from a point of view somewhat similar to that by which v. Baeyer appears to have been guided.

The fact that, under certain conditions, pinene behaves as a mon-ethenoid compound, and yet under others readily gives derivatives, such as the citrene dihydrochlorides, led him, several years ago, to consider the possibility of its being a trimethylene derivative, the simplest expression for which would be



It is unnecessary to point out how such a compound would pass into a citrene-dihydrochloride such as may be derived from Tiemann's citrene formula, the formation of which from a dipentamethylene derivative such as pinene is represented to be by both Bredt and Tiemann is very difficult to understand—not to say eminently improbable.

The explanation of the formation of a compound having the properties of the hydrochloride obtained from pinene—artificial camphor—offers perhaps the greatest difficulty at present. This compound can scarcely be a direct derivative of pinene, and seems to be closely related to camphor—in fact, the writer has obtained a small quantity of camphoric acid by its oxidation with nitric acid. It appears not improbable that some more or less profound change attends its formation, and, with the aid of the formula above given, it would not be difficult to represent the production from the trimethylene radicle of a new penta- or methyl-tetramethylene ring attached to contiguous

carbon atoms of the hexamethylene ring, and thus to arrive at a formula such as the writer long ago attributed to camphor.

That many of the derivatives obtained from camphor are the end products of a series of analytic and synthetic changes, there can be no doubt; it is impossible to explain the formation of substances so different as cymene, metacymene, ethyldimethylbenzene, carvacrol and acetylorthoxylene in any other way. At one time we thought but of its relation to cymene; latterly the relation of camphor to trimethylsuccinic acid has monopolised attention: but it may well be that the latter, like the former, is an elusive support, and owes its formation to atomic redistribution.

It may be pointed out that "artificial camphor," pinene nitrosochloride and pinene dibromide differ in a remarkable and significant manner in optical properties, the first alone being optically active. It is to be remembered that the carbon atoms which are connected by an ethenoid linkage in pinene cannot be the origin of its optical activity, and, whatever its formula, it must be one containing at least one asymmetric carbon atom. But, this being the case, it is difficult to understand how the addition, either of bromine or of nitrosyl chloride, can give rise to optically inactive products capable of affording an inactive pinene; the occurrence of "racematisation" in such a case would seem to indicate that the region in which the asymmetric carbon is situated also becomes affected, although, apparently, but temporarily: *i.e.*, whatever be the change, it is subsequently reversed—even when pinene is converted into the nitrosochloride. If we cannot accept this conclusion, we must admit that the formulæ hitherto attributed to pinene are all unsatisfactory expressions to a far greater extent than we have ever supposed. The difficulty, it may be added, is greater in the case of such a formula as Tiemann's—as this contains two asymmetric carbons—than in the case of those proposed by v. Baeyer, or by the writer.

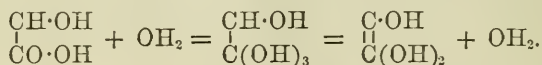
A similar argument is applicable in the case of camphor. If the argument of the following note be admitted, the production of an inactive campholide on reduction of camphoric anhydride (Haller, C. R., 1896, 295) may, in fact, be regarded not only as a proof that the CO group undergoing reduction is connected with an hydrogenised asymmetric carbon atom, but also as evidence of the presence of but a single asymmetric carbon in camphor.

24. "The conditions involved in the occurrence of inversion in the case of asymmetric (optically active) compounds. By Henry E. Armstrong.

Having formed the opinion that the changes which attend the production of what are supposed to be pinene derivatives merit much

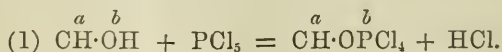
closer attention, the writer has been led to carefully consider Walden's recent very remarkable observations on the formation from each of the two active malic acids by means of phosphorus pentachloride or bromide of an oppositely active chloro- or bromo-succinic acid, from each of which in turn a malic acid of its own order of activity may be obtained (*Ber.*, 1896, 133). It does not appear difficult to explain these results without any modification of our current theory, and attention is now called to considerations which, perhaps, may prove to be of importance in discussions of the behaviour, and of other questions relating to, asymmetric compounds.

When opheal inversion is effected by hydrolytic agents, in the case of an aldose, or of a ketose or acid, it is probable that, in the first instance, the keto-group becomes hydrated, and that either an "aldehydrol," $\text{CH}(\text{OH})_2$, or a "ketohydrol," $\text{C}(\text{OH})_2$, or an "acid-hydrol," $\text{C}(\text{OH})_3$, is produced. When water is withdrawn from such compounds, if the water be formed from an OH-group of the hydrol complex and a hydrogen atom attached to the carbon contiguous to that of the hydrol complex, an ethenoid derivative will be formed, thus

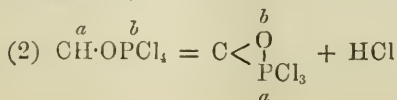


On hydration, according as hydration takes place at the one or the other junction of the ethenoid linkage, such a compound will afford one or the other of the two possible asymmetric forms; and if, as in the case of tartaric acid, the compound be symmetrical, it is to be expected that the two forms will be produced in equal proportions. But if an unsymmetrical compound be thus changed, such as a hexose or an acid like gluconic acid, it is to be expected that the severance will take place to a greater extent at one of the two junctions, and in some cases perhaps only at one. The striking results recently obtained by Lobry de Bruyn, and all E. Fischer's observations, are in accordance with this view, which, in fact, is the generally accepted one.

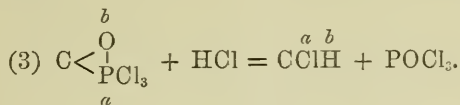
When malic acid is acted on by, say, phosphorus pentachloride, probably the first action to occur is one involving the formation of a chlorphosphonium compound, thus,



The next stage in the change may be assumed to be one involving "internal condensation,"



Supposing that this compound be then acted on by hydrogen chloride and resolved into chlorosuccinic acid and phosphorus oxychloride, if the attack became *directed* by the phosphorus, so that the chlorine took up the position of the phosphorus, complete inversion would be effected :



It will be obvious that such an explanation may be of general application, especially in connection with the exclusive production, under natural conditions, of a single asymmetric form.

*25. "The production of naphthalene and of isoquinoline derivatives from dehydracetic acid." By J. Norman Collie, Ph.D., and N. T. M. Wilsmore, M.Sc.

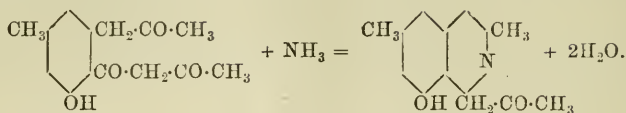
It was shown by one of the authors (Trans., 63, 329), that, under certain conditions, diacetylacetone condenses forming a yellow crystalline compound, apparently a benzene derivative, and that this further condenses easily, forming a second yellow compound, which was shown to be a derivative of naphthalene.

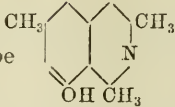
On the average, dehydracetic acid yields about a quarter of its weight of the first compound. A dioxime of the first yellow compound has been prepared in a nearly pure state. By distilling the diacetate of the second yellow compound with zinc dust, a naphthalene hydrocarbon, m. p. 75—78°, has been prepared. Its composition agrees well with that of a dimethylnaphthalene. On oxidation with dilute nitric acid it yields an acid, giving the fluorescein reaction. Analysis of the silver salt of this acid agrees with the composition $\text{C}_9\text{H}_6\text{O}_2\text{Ag}_2$; and the melting point, 115—120°, coincides fairly well with that found for benzene 1 methyl 3, 4 dicarboxylic acid (Ber., 1892, 2108). By the action of strong sulphuric acid on the second yellow compound (dimethylacetodinaphthol), a colourless substance results.

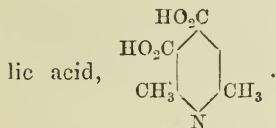
By the action of strong ammonia on the first yellow compound, a yellow basic substance ($\text{C}_{14}\text{H}_{15}\text{NO}_2$) is produced, soluble in water and in alcohol, forming intensely yellow solutions. The chloride and platinichloride were prepared and analysed. On heating with strong sulphuric acid, acetic acid is given off, and the sulphate of another base is left. This base has the composition $\text{C}_{12}\text{H}_{13}\text{NO}$. On oxidation it yielded an acid, which appeared to be a lutidine dicarboxylic acid, $\text{C}_9\text{H}_9\text{NO}_4$.

The authors consider it probable that these bases are derivatives

of isoquinoline formed by condensation of the yellow benzene compound with ammonia.



The second base would be , and the lutidine dicarboxylic acid,



*26. "Note on a difficulty encountered in the determination of nitrogen by the absolute method." By Wyndham R. Dunstan, F.R.S., and F. H. Carr.

The percentage of nitrogen in aconitine determined by the soda-lime process, using the base, or by the absolute method, using the hydrochloride, agrees well with that calculated from the formula $\text{C}_{23}\text{H}_{45}\text{NO}_{12}$, which is 2.1 per cent. A few years ago Richards and Rogers (*Chemist and Druggist*, 38, 242) stated that when the amount of "nitrogen" in aconitine is determined in the usual manner by the absolute method, it is found to correspond with nearly twice the percentage calculated from the formula given above, and they, therefore, proposed to alter the formula of aconitine to $\text{C}_{23}\text{H}_{43}\text{N}_2\text{O}_{12}$, in accordance with the results of their determinations. At that time the present writers were unable to look into the cause of these high results, but they were satisfied as to the accuracy of previous determinations (with the hydrochloride), showing that the molecule of the alkaloid contains but one atom of nitrogen. Recently they have had occasion to determine the nitrogen in the base by the absolute method, the air being expelled from the combustion tube by carbon dioxide and the gas collected in an azotometer. They were surprised to find that over 4 per cent. of gas was obtained instead of 2.1 per cent., the calculated quantity. The determination has since been repeated by four independent observers, every precaution being taken to ensure complete combustion by employing a long layer (about 60 cm.) of red-hot copper oxide, and by conducting the burning slowly. The percentages obtained were 4.4, 5.3, 5.1, 3.8, 4.0, 4.1, 4.3. The highest percentages were obtained when the burning was conducted at about the usual rate, the lowest numbers by burning extremely slowly and maintaining the temperature as high as possible

throughout the process. Similar results were obtained when the combustion was conducted in a vacuum, and the gas drawn off through a Sprengel pump in the manner suggested by Frankland and Armstrong. The hydrochloride of the alkaloid, however, when burned in either way, gives a percentage only slightly higher than the calculated amount. Strychnine and some other typical nitrogenous organic compounds have been burnt in precisely the same manner as aconitine, but the percentages found were, as usual, only slightly higher than those calculated from the formula.

A quantity of this gas having been collected in different experiments which had given too high results, a complete analysis of it was made. Nitric oxide and carbon monoxide were absent. By exploding with excess of oxygen, measuring the contraction, and absorbing the carbon dioxide, methane was proved to be present. Estimating the methane in the mixed gas, and deducting it from the total volume taken, the nitrogen amounted to almost exactly 2.1 per cent., corresponding with that calculated from the formula $C_{33}H_{45}NO_{12}$.

Experiments made with artificially prepared mixtures have shown that when largely diluted with nitrogen, methane is burnt very slowly and with difficulty by red-hot copper oxide. In conducting the process in the usual manner the influence of the carbon dioxide used to expel the air from the tube, no doubt greatly aggravates the difficulty. Aconitine seems to be exceptional in giving rise to so much methane during combustion. Possibly the difficulty might be overcome by mixing the alkaloid, not merely with finely powdered copper oxide, but also with a more powerful oxidising agent, as, for example, lead chromate. Neither aconitine hydrochloride, benzaconine, nor aconine hydrochloride present this anomaly, and it has been observed that if aconitine is introduced into the tube along with a little cuprous chloride, the percentage of gas obtained corresponds very nearly with the calculated quantity.

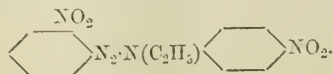
27. "Mixed diazoamides containing an orthonitro-group." By Raphael Meldola, F.R.S., and Frederick William Streatfeild, F.I.C.

Orthodinitro-diazoamidobenzene, which was prepared and described by the authors in their last communication on this subject (*Trans.*, 1894, 52), does not appear to be capable of ethylation by the usual methods (*loc. cit.*). As this is the first exception that has yet been found to the general method of alkylating the diazoamides introduced by the authors in 1886 (*Trans.*, 1886, 624), it became of special interest to ascertain whether the usual triplet of isomerides could be prepared when an orthonitro-group was present on one side of the chain of nitrogen atoms. The mixed diazoamide from ortho- and para-nitraniline was prepared by both methods of combination in the usual

way, and the product found to be identical irrespective of the order of diazotising. So far the production of the compound is quite normal. After crystallisation from alcohol it consists of goldenyellow scales melting with decomposition at 192—193° when the temperature is raised rapidly. The formula is written $(o)\text{NO}_2\cdot\text{C}_6\text{H}_4\cdot\text{N}_3\text{H}\cdot\text{C}_6\text{H}_4\cdot\text{NO}_2(p)$. The compound is decomposed by excess of strong hydrochloric acid at ordinary temperatures into the usual mixture of four products, viz., ortho- and para-nitraniline and the corresponding diazo-chlorides. It has the acid characters common to all the dinitrodiazo-amides, dissolving in alkaline solutions with a reddish colour, and being precipitated unchanged by acids. By the action of ethyl iodide on the potassium salt in alcoholic solution the ethyl derivative is obtained in the usual way. The latter consists of orange needles melting at 177—179°.

A special attempt was made in this case to separate the mixed diazoamide into isomerides by fractional ethylation, but the result was negative, the product being simply a mixture of unethylated compound (m. p. 192—193°) and the ethyl derivative (m. p. 177—178°). Under all circumstances, the ethylation of this diazoamide is incomplete, a certain amount of unchanged substance being left in the mother liquor, even when potassium hydroxide and ethyl iodide are used in excess.

The behaviour of the ethyl derivative towards hydrochloric acid is quite exceptional, and the products of its decomposition are ethyl-*p*-nitraniline and orthonitrodiazobenzene chloride. This is the first instance which has come under our observation in which an alkyl-diazoamide from the direct alkylation of a mixed diazoamide has given only two instead of four products on decomposition by acid. This ethyl derivative is also remarkable for its stability towards hydrochloric acid, as it had to be kept at a temperature of about 80—90° for some hours in presence of a large excess of acid before decomposition was complete. Not a trace of nitrogen was evolved during the decomposition. The products were identified by filtering the cold acid solution into an alkaline solution of β -naphthol (Trans., 1887, 438) and collecting the bright red precipitate which at once formed. The latter, after washing with water, was extracted with hydrochloric acid which removed ethyl-*p*-nitraniline; melting point of nitrosamine 119—120° (Trans., 1886, 631). The red residue proved to be orthonitrobenzeneazo- β -naphthol, m. p. 210° (Meldola and Hughes, Trans., 1891, 374). These results indicate for the ethyl derivative the definite formula



This view was confirmed by combining diazotised orthonitraniline with ethyl-*p*-nitraniline when the same compound (m. p. 177—179°) was obtained and not an isomeride.

The explanation of the exceptional behaviour of this ethyl derivative is bound up with the general question of the "protecting influence" of a nitro-group in the ortho-position, as shown more especially by the recent researches in Victor Meyer's laboratory, which bring out very clearly the influence of ortho-substituents in preventing alkylation of the carboxyl group.

The System $X < \begin{smallmatrix} \text{NO}_2 \\ \text{NH} \cdot \text{N}_2 \cdot \text{Y} \end{smallmatrix}$ is incapable of being alkylated when NO_2 and NH are in the ortho-position. An attempt to prepare the isomeride by the action of diazotised paranitraniline on ethyl-*o*-nitraniline brought out still more forcibly the influence of the orthonitro-group. Combination could not be effected under any of the conditions which so readily furnish the other alkyl diazoamides; paranitrodiazobenzene chloride does not appear to have any action on ethyl-*o*-nitraniline.

It may be of interest to state in conclusion that these results are of great importance as establishing the fixity of the alkyl group when once introduced into a diazoamide. If this group were at all "labile," it might have been expected that by the action of diazotised paranitraniline on ethyl-*o*-nitraniline the same compound would have been obtained as by the action of diazotised orthonitraniline on ethyl-*p*-nitraniline. In the former case, as we have proved, the compounds remain for days in contact without combining. The difficulty which we have experienced in preparing ethyl-*o*-nitraniline is also due to this same influence of the orthonitro-group. Since orthodinitrodiazamidobenzene cannot be ethylated, we were unable to prepare it by the decomposition of this compound. Attempts to ethylate orthonitraniline directly gave unsatisfactory results, as also did the published methods (*Beilstein*, vol. II, 332). The simplest method, according to our experience, is to heat orthonitrophenol ether (ethyl) with alcoholic ethylamine in a sealed tube for 12 hours at 150°.

23. "Allyl-*p*-dinitrodiazoamidobenzene: a study of the relations between melting point and constitution." By Raphael Meldola, F.R.S., and Frederick William Streatfeild, F.I.C.

As the introduction of alkyls into diazoamides always lowers the melting point, the lowering being greater the greater the weight of the homologous radicles introduced, the above compound was prepared with a view to ascertaining whether the same rule holds good for unsaturated radicles. It was found that paradinitrodiazoamidobenzene could be quite readily converted into an alkyl derivative by the action of potassium hydroxide and allyl iodide in the usual way. The pure compound forms small yellow needles, m. p. 164—165°.

0.0826 gave 15.1 c.c. moist nitrogen at 14.5° and 759.4 mm. = 21.42 N.

$(p)\text{NO}_2\cdot\text{C}_6\text{H}_4\cdot\text{N}_2\cdot\text{N}(\text{C}_6\text{H}_5)\cdot\text{C}_6\text{H}_4\cdot\text{NO}_2(p)$ requires N = 21.40 per cent.

The melting point of the original compound is about 236° (if the temperature is raised very rapidly), of the methyl derivative 219° , of the ethyl derivative $191\text{--}192^{\circ}$, and of the benzyl derivative 190° (Trans., 1887, 112). Taking the upper limit of temperature at which the original compound decomposes (236°) the depression produced by methyl is 17° , ethyl 44° , benzyl 46° , and allyl 71° . It thus appears that the unsaturated radicle lowers the melting point to the same extent (27°) as the difference between the methyl and ethyl derivatives, and so far allyl may be said to exert a normal influence. In other words, the difference between the allyl and ethyl derivative is the same as between the ethyl and methyl derivative. Since benzyl produces practically the same lowering as ethyl, it would further appear that the nature of the group in direct combination with the nitrogen atom is of paramount influence, and that any other radicles associated with this group, such as C_6H_5 in $\text{CH}_2\cdot\text{C}_6\text{H}_5$, are of subsidiary influence. The actual weight of the introduced radicle is thus of small importance as compared with its constitution.

At the next meeting on Thursday, March 5th, the following papers will be read:—

“The explosion of cyanogen.” By Professor H. B. Dixon, F.R.S., E. H. Strange, and E. Graham.

“The mode of burning of carbon.” By Professor H. B. Dixon.

“The detonation of chlorine peroxide.” By Professor H. B. Dixon and J. A. Harker.

“The combination of carbon and hydrogen.” By Dr. Bone and D. S. Jerdan.

PROCEEDINGS

OF THE

CHEMICAL SOCIETY.

EDITED BY THE SECRETARIES.

No. 162.

Session 1895-96.

March 5th, 1896. Mr. A. G. Vernon Harcourt, President, in the
chair.

Messrs. Alexander Simpson, Joseph John Bowley, Walter A. Voss,
and William A Bone were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs.
John Percival Jenkins, 30, St. John's Road, Clifton, Bristol;
Tom Mitchell, Cemetery House, Shaw, near Oldham; Raymond St.
George Ross, 30, Britannia Square, Worcester.

Of the following papers those marked * were read:—

*29. "The explosion of cyanogen." By H. B. Dixon, M.A., F.R.S.,
E. H. Strange, B.Sc., and E. Graham, B.Sc.

Since it has been shown by previous investigations that cyanogen probably burns first to carbonic oxide, and secondly to carbon dioxide, both in ordinary flames and in the explosion wave, and since the burning of carbonic oxide to carbon dioxide appears to be generally conditioned by the presence of water vapour, it seemed of interest to investigate the course of the chemical changes occurring in the complete combustion of cyanogen.

The authors first measured the rate of explosion of cyanogen with an excess of oxygen. The conclusion drawn is that when cyanogen is exploded with its own volume of oxygen it burns directly to carbonic oxide; on adding a second volume of oxygen to the mixture, carbonic oxide is formed in the wave-front, and the heated carbonic oxide and oxygen combine behind the wave-front; on adding more oxygen the

formation of carbon dioxide is sufficiently rapid to affect the velocity of the wave itself. When one volume of cyanogen is exploded with four volumes of oxygen, the rate is 5 per cent. faster than the rate calculated on the supposition that the cyanogen is only burning to carbonic oxide in the wave-front. The formation of carbon dioxide, although without influence on the velocity of the wave in the faster explosions, is found to exert an influence in the slower explosions.

In order to study the intensity and duration of the flame following the explosion wave, photographs were taken of the jets of flame projected from the ends of long tubes filled with the explosive mixtures of cyanogen and oxygen. Since the wave travels faster than sound in the unburnt gas the wave-front must reach the end of the tube before any other disturbance can be propagated through the gas; the jet of flame which is driven from the tube must accordingly be part of the column of burning gases following in the wake of the wave. When cyanogen is burnt with its own volume of oxygen to carbonic oxide, the intensity of the explosion is very great, but only a very slight jet of flame is projected from the tube. The length of column of highly heated gases must be short. But when cyanogen is burnt with twice its volume of oxygen to carbon dioxide the explosion is less intense, but the jet of flame projected from the tube is long and of considerable brightness. The column of highly heated gases must therefore be long. If the extra oxygen is inert in the wave-front it accounts for the superior brilliancy of the unimpeded reaction $\text{C}_2\text{N}_2 + \text{O}_2 \approx 2\text{CO} + \text{N}_2$ over the impeded reaction $\text{C}_2\text{N}_2 + 2\text{O}_2 = 2\text{CO} + \text{O}_2 + \text{N}_2$, and if the formation of carbon dioxide mainly occurs behind the wave, it accounts for the brightness of the jet of still burning gases thrown from the tube in the second case.

To obtain a direct record of the intensity and length of flame in the two cases, the explosion wave was photographed on a very rapidly moving film as it passed a short window in a long tube. The sensitive film was fixed round a light iron drum driven by a high speed electric motor. Two tubes, each provided with a window, were fixed side by side, one being filled with one mixture, the second with the other. The gases being fired simultaneously, the two flames were photographed on the same film. On developing the film in a long trough each image received precisely the same treatment, and one could be compared with the other.

The front of the flame in all cases was sharply defined, but the rear of the flame dies away in a tail which gradually thins out. When cyanogen is exploded with its own volume of oxygen, an intense image of the window is produced, only slightly drawn out by the revolution of the drum, followed by a faint and short tail. When, however, cyanogen is exploded with twice its volume of oxygen, the

image is not so bright and there is no abrupt fall in intensity; the tail is much brighter and longer. These photographs accord with the view that cyanogen burns first to carbonic oxide, and that the formation of carbon dioxide is a secondary action.

Photographs were then taken with the same apparatus of the flames produced by mixtures of cyanogen with two vols. of oxygen (1) well dried, and (2) moist. No difference could be detected in the images of the flames. Water-vapour, therefore, does not seem to affect the reaction between oxygen and the just-formed carbonic oxide. Similar photographs of the flames produced in mixtures of carbonic oxide and oxygen in the dry and moist state showed a marked difference; in the presence of steam the flame is intenser and shorter.

*30. "On the mode of formation of carbon dioxide in the burning of carbon-compounds." By H. B. Dixon, M.A., F.R.S.

Assuming that in the combustion of carbon compounds the carbon burns first to carbonic oxide, the author discusses the views that have been advanced concerning the function of steam in promoting the union of carbonic oxide and oxygen.

Professor Armstrong considers that the moisture acts as an electrolyte, and that chemical change only takes place when carbonic oxide, steam, and oxygen are in contact. The chief difficulty in this theory is to account for the great velocity with which the explosion wave is propagated through a damp mixture of carbonic oxide and oxygen. In gaseous mixtures the rate of explosion approximates to the rate of the forward movement of the reacting molecules, *i.e.*, the wave is transmitted like sound from molecule to molecule. According to the electrolytic theory, the chemical change could only occur on the simultaneous collision of at least three molecules; yet the explosion wave is propagated in carbonic oxide, steam, and oxygen at a rate of 1738 metres per second. In the explosion of cyanogen, carbon dioxide is formed without the intervention of steam. This theory, which has the advantage of including a number of cognate phenomena, seems better suited to explain reactions at ordinary temperatures than those occurring in the explosion wave.

A similar difficulty occurs in Professor J. J. Thomson's theory, according to which the steam, by forming liquid particles, produces dissociation of the oxygen molecules, and thus facilitates the oxidation of the carbonic oxide. It is hard to understand how steam, which is far below the saturation point at ordinary temperatures, can be condensed in the explosion wave.

Mendeléef considers that carbonic oxide cannot combine directly

with oxygen because all combination between gases takes place according to the law of equal volumes. Carbonic oxide and steam react in equal volumes, and therefore the change begins by the carbonic oxide taking the oxygen from the steam. The liberated hydrogen unites with its own volume of oxygen to form hydrogen peroxide, and this in turn reacts with its own volume of carbonic oxide to form carbon dioxide and water. The spark will not, however, kindle a mixture of dried carbonic oxide and nitrous oxide (mixed in equal volumes), but the addition of a trace of steam renders the mixture explosive.

Lothar Meyer and Beketoff attribute the influence of the steam to the fact that the direct action of carbonic oxide on oxygen requires a very high temperature, whereas carbonic oxide decomposes steam much more readily. But although it may be true that steam facilitates the oxidation of carbonic oxide on account of the low temperature of the reaction, this does not account for the non-union of carbonic oxide and oxygen at the intensely high temperature produced in the wave-front in the explosion of cyanogen.

The author shows that a dried mixture of carbonic oxide and ozonised oxygen is not inflamed by the spark; here the resistance cannot be attributed to the stability of the oxygen.

The author has repeated Beketoff's experiment of exploding together a mixture of cyanogen, carbonic oxide, and oxygen in the dry state. With quantities of cyanogen below 12 per cent. the flame causes an *incomplete* combustion of the carbonic oxide. The same results were obtained when carbon bisulphide was substituted for cyanogen. The more intense the exciting flame, the larger was the amount of carbonic oxide burnt.

The dissociation of carbon dioxide, held by Bunsen and by Deville to limit the combustion of carbonic oxide and oxygen, may be the reason why carbonic oxide and oxygen do not unite in the wave-front, but can combine as the gases cool down behind the wave. The reaction between steam and carbonic oxide gives out little heat, so carbonic acid might be formed indirectly, and the liberated hydrogen might re-form steam, which could exist at a temperature at which carbonic acid would be broken up. The union of dry carbonic oxide and oxygen, without flame, on the surface of platinum may be due partly to the power of the metal to conduct away heat.

The dissociation theory explains some of the facts observed concerning the combustion of carbonic oxide, but probably some other cause exists which limits the union of carbonic oxide and oxygen at lower temperatures.

The Röntgen rays do not appear to make a dried mixture of carbonic oxide and oxygen inflammable.

*31. "On the explosion of chlorine peroxide." By H. B. Dixon, M.A., F.R.S., and J. A. Harker, D.Sc.

The decomposition by shock of endothermic compounds, discovered by M. Berthelot, and the explosion of carbon bisulphide vapour described by Dr. Thorpe, led the authors to determine whether a true explosion-wave was transmitted through these compounds. It was found, however, that when a charge of fulminate was fired in a steel bomb attached to a long tube filled with cyanogen or acetylene, the detonation was not transmitted through the gas in the tube except for a short distance. With carbon bisulphide the flame extended for some distance, but gradually died out. M. Maquenne has recently obtained similar results.

A mixture of chlorine peroxide and oxygen (with a trace of chlorine) was prepared by warming potassium chlorate with sulphuric acid. The gases were passed up through a long, glass tube, 33 ft. long, inclined at an angle of 30° . When the tube was full, "bridge-pieces" were clamped on at each end. The explosion was started by igniting a mixture of hydrogen and oxygen in one bridge-piece. The explosion wave set up in this was communicated to the chlorine peroxide. By making the explosion break a silver bridge (coated with paraffin) at each end of the tube, the rate of the explosion was determined on the electric chronograph. A sample of the gas for analysis was collected at the end of the tube.

In two experiments the following results were obtained.

Composition of mixture.	Rate of explosion in metres per second.
1. $\left\{ \begin{array}{l} \text{ClO}_2 \dots\dots 53\cdot5 \\ \text{O}_2 \dots\dots\dots 46\cdot5 \end{array} \right\} \dots\dots\dots$	1065
2. $\left\{ \begin{array}{l} \text{ClO}_2 \dots\dots 64\cdot0 \\ \text{O}_2 \dots\dots\dots 36\cdot0 \end{array} \right\} \dots\dots\dots$	1126

It would appear, therefore, that a true explosion-wave is propagated through chlorine peroxide.

*32. "Note on the use of certain phosphorescent substances in rendering x-rays visible." By Herbert Jackson.

In a former paper on "Observations on the Nature of Phosphorescence" (Trans., 1894, 734), the author drew attention to the similar nature of the phenomena of phosphorescence obtained with various substances placed either inside or outside of a vacuum tube.

Since the publication of that paper, the work has been continued, mainly with a view to studying the relation of phosphorescence to the chemical structure, and more especially to the spectra of the substances which exhibit the phenomena. The present note is put forward because the author's experience has enabled him to obtain useful results in the attempt to render certain structures, &c., visible by means of the radiations, the effect of which on photographic plates has latterly attracted so much attention.

The existence of something proceeding from a vacuum tube capable of penetrating many otherwise opaque bodies was first made public by Lenard. The author employed at the time, and has since used, such substances as ebonite, metals, and other opaque sheets as windows or covers to vacuum tubes in studying phosphorescence with such receptive substances as the platinicyanides, the oxides and carbonates of many metals, and the sodium, potassium, and lithium haloids.

The knowledge of the nature of the radiations which induce phosphorescence in many substances outside a vacuum tube has recently been very greatly added to by Professor Röntgen's discovery that they exhibit none of the phenomena of refraction, diffraction, and interference. To this important discovery he has added the interesting observation of the relative transparencies of bone and flesh.

The vacuum tube most suitable for showing the phenomena, in the writer's experience, is a slight modification only of one invented by Mr. Crookes to illustrate the heating effect of focussed radiant matter.

It consists of a concave aluminium cathode and a platinum anode. The latter is inclined at an angle of 45° , and spreads the rays from the cathode in every possible direction, apparently by scattered reflection.

Such a tube has been regularly employed by the author in experiments upon the phosphorescence of the platinicyanides, and of some 300 other substances, and was first used by him in January, 1894. About 70 tubes were made in the attempt to obtain the best results, but so far the one described has proved to be the most active.

To obtain good results the vacuum must be high. Apparently the nature of the residual gas does not affect the working of the tube in any marked manner. Both Dr. Norman Collie and the author have tried a number of gases without noticing any marked difference. This may be largely due to the fact that if a mercury pump be used a very considerable percentage of the residual gas is the vapour of that metal.

The most brilliantly phosphorescent substance yet obtained is potassium platinicyanide. This salt crystallises with three molecular

proportions of water, and is most active in its fully hydrated state. It effloresces, and should therefore be used in such a way that either it cannot lose water or can be readily moistened. If this platini-cyanide be painted on to black cardboard, or thin vulcanite, &c., its phosphorescence will enable transparent and opaque objects to be clearly differentiated.

The particular potassium salt was chosen from considerations of the brilliant expanse of blue seen in the spectrum of compounds of that metal. Many of the other platini-cyanides have been tried as well as a number of the platamine salts. With none of them is the amount of light equal to that of the potassium salt.

A study of the phenomena during the exhaustion of the tube shows that the rays (it is convenient to speak of rays) proceeding from the concave cathode meet apparently at the centre of curvature and diverge in a solid cone. As the vacuum becomes higher this cone narrows until, when the exhaustion required for the maximum phosphorescence outside the tube is attained, it apparently becomes a straight line.

If, as at present observation seems to indicate, the rays from the cathode are still brought to a focus at the centre of curvature, the fact that they proceed thence in a straight line gives a material aspect to the phenomenon, as this would be the behaviour of particles coming at right angles from the surface of a concave disc, and colliding at the centre of curvature. This, however, would require the assumption that the particles are non-elastic. It is possible that only the centre of the electrode is implicated at high exhaustions. The author is conducting experiments with a view to settle this question of the path of the rays. It does not seem probable that the radiation is confined to the centre, because a straight cathode gives none of the effects observed when the concave form is used. When the rays meet the reflecting platinum plate, which is conveniently, but not necessarily, made the anode, they are scattered by the relatively coarse surface of the metal, a very small circle upon which becomes the radiant. This is shown by experiments with phosphorescent substances placed upon the platinum, and by examining the tube through a pinhole in an opaque metal sheet by means of a phosphorescent screen. The results obtained are only consistent with the source of illumination being a point or a very small circle. The alternative to the view that the cathode is the true original source of the exciting cause, and that the rays proceed from the glass is disproved by using flat and curved tubes. A point as the illuminative source would be obtained if rays proceeded at right angles from the surface of a curved glass but not from a flat one.

In his previous paper the author attempted to show that all the

phenomena of phosphorescence, either inside or outside a vacuum tube were best explained on the assumption that the exciting cause proceeding from the cathode was of the nature of light, or was capable of setting into vibration the residual gas particles so as to give rise to undulations of the nature of light. Professor Röntgen has expressed an opinion in favour of longitudinal vibrations. The author adheres at present to the notion of transverse vibrations, and hopes before long to bring further experimental evidence before the Society in dealing with his work on the relation of the spectra of substances to their phosphorescence.

DISCUSSION.

Sir JOSEPH LISTER, remarked on the probable importance to medicine and surgery of the discovery that the shadows produced by the Röntgen rays could be rendered visible to the naked eye in the manner which had been demonstrated by Mr. Jackson.

Dr. ARMSTRONG thought it would be found, when Mr. Jackson's full communication was studied, that he had not only materially advanced the application of Röntgen's most remarkable discovery, but also added much to our knowledge of the phenomena concerned. His success was due to no chance observations, but was the outcome of prolonged, thoroughly scientific study of phosphorescent phenomena, and a development of his previous work.

It was certainly very startling to see, with the aid of a mere screen held before the eyes, the bones in the foot right through the boot, and to learn that a photograph could be secured in the merest fraction of a second with the aid of such a screen. He believed that Mr. Jackson was of opinion that there were a great variety of Röntgen radiations, and that different objects were opaque to these in different degrees; so that it might ere long be possible, by properly selecting the radiations, to distinguish objects much more closely related than bones and flesh.

*33. "The union of carbon and hydrogen." By William A. Bone, M.Sc., Ph.D., and David S. Jordan, M.A., B.Sc.

Two years ago, one of the authors, in conjunction with J. C. Cain (Proc., 1894, 56), observed that when a mixture of cyanogen and hydrogen is fired in a long lead coil with a volume of oxygen insufficient to burn all the carbon present to carbon monoxide, a small amount of methane, varying from 1.0 to 1.7 per cent., according to the composition of the original mixture, was found among the products of explosion. This seemed to indicate the possibility of the formation of methane by the union of its elements at the high tem-

perature of the explosion wave, and the authors undertook the following experiments, with a view of testing this hypothesis. They have investigated (1) the effect of heating carefully purified carbon (obtained by heating sugar charcoal in chlorine and subsequently in hydrogen until all the chlorine was expelled) in a glazed Berlin porcelain tube to white heat in an atmosphere of dry hydrogen free from hydrocarbons; and (2) the action of carbon upon hydrogen at the temperature of the electric arc.

In the first series of experiments the porcelain tube was heated in a Fletcher injector furnace by means of an air-coal gas blow-pipe. In order to avoid the possibility of the diffusion of furnace gases through the porcelain tube, it was placed inside a wider tube of the same material, and a current of hydrogen was passed through the annular space between them. Several blank experiments were performed, in which hydrogen free from hydrocarbons was passed through the inner tube and through the jacket, whilst the tubes were maintained at a white heat; samples of hydrogen taken from the inner tube during the course of an experiment were found, on analysis, to contain no carbon compound. The purified carbon, after being dried over phosphoric anhydride for two months, was strongly heated in a hard glass tube attached to a Sprengel air-pump, and was then sealed up in a vacuum with quicklime. This carbon was introduced into the inner porcelain tube, and was heated to white heat in a current of hydrogen free from hydrocarbons, whilst simultaneously a current of the same hydrogen was passed through the space between the inner and outer tubes. Samples of the exit gases from the inner tube were afterwards carefully analysed; they were found to contain no acetylene or other unsaturated hydrocarbon, but about 1 per cent. of methane. In another experiment, a volume of hydrogen was enclosed in the inner tube, heated for three hours in contact with the carbon; on subsequently analysing the gas, it was found to contain nearly 2 per cent. of methane.

In the second series of experiments, the electric arc was formed between terminals of purified gas-carbon in an atmosphere of dry hydrogen free from hydrocarbons, contained in a glass globe standing in a trough over mercury. Each of the carbon terminals, which had been previously strongly heated for several hours in a hard glass tube connected with a Sprengel air-pump, was attached to a stout copper wire, which in turn was fixed into a piece of narrow glass tubing bent into U shape and filled with mercury. The limb of the U-tube bearing the carbon was then thrust into the globe from below the surface of the mercury in the trough. The top of the globe was drawn out and sealed to a three-way tap, by means of which connections could be made, on the one hand, with an air pump or the supply

of hydrogen, and, on the other hand, to a nitrometer full of mercury, which served to collect samples of the gas in the globe at intervals during an experiment.

At the outset of an experiment, the globe was exhausted of air by attaching it to a working air-pump until it was completely filled with mercury. Then dry hydrogen was introduced, and the arc passed between the terminals for about a quarter of an hour. The globe was again exhausted, and finally filled with the dry purified hydrogen. The arc was then passed for a period of time varying from 30 minutes in the first experiment to two hours in the last, and at the end of 5, 15, 30, etc., minutes in each experiment, samples of the gas were drawn off for analysis.

Composition of the Gases.—The gases were always found to contain small amounts of hydrocyanic acid, due no doubt to the presence of a little nitrogen in the hydrogen employed. Acetylene was also present in considerable quantity, and was detected by passing the gas through an ammoniacal solution of silver chloride, when a copious precipitate of silver acetylide was formed. A detailed analysis of the gases showed, however, that, in addition to acetylene or other unsaturated hydrocarbon, they invariably contained an appreciable amount of some saturated hydrocarbon, most probably methane.

Experi- ment.	Gases drawn off after ..	Minutes.						
		5.	15.	30.	45.	60.	90.	120.
A	Absorption by solid potash [hydrocyanic acid]	0·20	1·01	1·51	—	—	—	—
	Absorption by fuming sulphuric acid and cuprous chloride solution, <i>i.e.</i> , ethylene, acetylene	5·10	8·43	9·85	—	—	—	—
	Methane	1·32	2·20	2·46	—	—	—	—
B	Absorption by solid potash [hydrocyanic acid]	0·11	0·20	0·12	0·20	—	—	—
	Absorption by fuming sulphuric acid and cuprous chloride solution, <i>i.e.</i> , ethylene, acetylene	2·13	4·99	6·41	8·08	—	—	—
	Methane	0·64	1·38	2·26	2·26	—	—	—
C	Absorption by solid potash [hydrocyanic acid]	trace	trace	0·10	—	0·53	1·00	0·39
	Absorption by fuming sulphuric acid and cuprous chloride solution, <i>i.e.</i> , ethylene, acetylene	2·12	4·70	6·16	—	6·83	6·42	7·59
	Methane	1·00	1·63	2·37	—	2·71	2·15	2·62

The gases were analysed in a modified form of the McLeod apparatus. A large volume of the gas was successively treated with solid potash, fuming sulphuric acid, acid solution of cuprous chloride, and a dilute solution of potash, in order that all hydrocyanic acid, unsaturated hydrocarbon, and any traces of carbonic oxide might be removed; a portion of the residual gas was then exploded with excess of air, free from carbon dioxide, and the contraction and absorption by potash solution after the explosion determined. Finally the excess of oxygen was absorbed by means of alkaline pyrogallate, and the residual nitrogen measured.

The results of the analyses are tabulated in percentages.

In all three experiments an alternating current from a dynamo was used. In Experiment A, the voltage was 160, and in B and C, between 40 and 60, but it was extremely difficult to maintain a constant voltage throughout a long experiment.

34. "Note on the α , γ -dimethylglutaric acids." By William A. Bone, M.Sc., Ph.D., and W. H. Perkin, junr., F.R.S.

The authors are now able to confirm the observation of Thorpe and Auwers (*Ber.*, 28, 623) that the acid melting at 105—107° which they described in a paper published last year (*Trans.*, 1895, 416) is really an equimolecular mixture of trans- and cis-dimethylglutaric acids melting at 140—141° and 127° respectively. This equimolecular mixture which in many respects behaves like a homogeneous substance, having, for example, a fairly sharp and constant melting point, may be resolved into its constituent acids by careful treatment with acetyl chloride, when the cis-acid yields an anhydride, whilst the trans-acid is unchanged, or by fractional precipitation of the acid calcium salts, that of the trans-acid being least soluble.

35. "The symmetrical dimethylsuccinic acids." By William A. Bone, M.Sc., Ph.D., and W. H. Perkin, junr., F.R.S.

During the course of their investigations on trimethylsuccinic and α , γ -dimethylglutaric acids last year, the authors obtained a considerable quantity of ethylic dimethylcyanosuccinate as a bye-product of the action of potassium cyanide on ethylic α -bromopropionate in alcoholic solution (*Trans.*, 1895, 416). On hydrolysing this ethereal salt by means of concentrated hydrochloric acid they obtained a mixture of trans- and cis-dimethylsuccinic acids, which they were able to separate either by fractional crystallisation from water or by a fractional precipitation of their calcium salts. After studying the literature of the subject, the authors found that the properties of the dimethylsuccinic acids which they had obtained differed considerably from

those assigned to them by previous investigators, and they therefore submitted these acids and their anhydrides to a careful examination.

They also prepared the dimethylsuccinic acids by the action of ethylic α -bromopropionate on the sodium compound of ethylic methylmalonate, subsequent hydrolysis of the resulting ethereal salt by means of alcoholic potash, and then heating the tribasic acid so obtained to 200° until all evolution of carbonic anhydride had ceased. The resulting acids were in all respects identical with those obtained by the first method.

Trans-dimethylsuccinic acid when pure melts at 209° , and is very much less soluble in water than the cis-acid, which melts at 129° . The calcium salt of the trans-acid is, however, much more soluble in water than that of the cis-acid. Each acid, when treated with acetyl chloride or acetic anhydride, yields its own anhydride, a fact first observed by Otto and Rössing (*Ber.* 20, 2736) and confirmed by Bischoff; the trans-anhydride melts at 43° (not 38° as given by Bischoff) and is less stable than the cis-anhydride, which melts at 88° , and is completely transformed into the last-named substance on prolonged heating with acetic anhydride. Both acids, on distillation at atmospheric pressure, yield the cis-anhydride. Each anhydride dissolves in hot water yielding its own acid, not, as some authorities have stated, a mixture of cis- and trans-acids.

36. "The cis- and trans-methylisopropylsuccinic acids." By William Hen. y Bentley, William Henry Perkin, junr., and Jocelyn F. Thorpe.

The authors have studied the action of ethylic α -bromoisovalerate on the sodium compound of ethylic methylmalonate in alcoholic and in xylene solution, and find that in both cases the product of the reaction consists of *ethylic isopropylmethylethanetricarboxylate*, $\text{COOC}_2\text{H}_5 \cdot \text{CH}(\text{C}_3\text{H}_7) \cdot \text{C}(\text{CH}_3)(\text{COOC}_2\text{H}_5)_2$, a colourless oil, which boils at $200\text{--}209^\circ$ (80 mm.).

This oil, on hydrolysis and subsequent elimination of carbon dioxide, yields a mixture of cis- and trans-*methylisopropylsuccinic acids*, which are separated by methods described in detail in the paper.

Cis-*methylisopropylsuccinic acid*, $\begin{array}{c} \text{CH}_3 \cdot \text{CH} \cdot \text{COOH} \\ | \\ \text{C}_3\text{H}_7 \cdot \text{CH} \cdot \text{COOH} \end{array}$, melts at $125\text{--}126^\circ$, and, when heated with hydrochloric acid at 180° , is partially converted into the trans-modification; when distilled or digested with acetic anhydride, it yields a liquid anhydride boiling at $138\text{--}140^\circ$ (35 mm.).

The *anilic acid*, $\text{COOH} \cdot \text{CH}(\text{C}_3\text{H}_7) \cdot \text{CH}(\text{CH}_3) \cdot \text{CONHC}_6\text{H}_5(?)$, melts at 153° , and, at a somewhat higher temperature, loses water with formation of the corresponding *anil*, $\begin{array}{c} \text{CH}_3 \cdot \text{CH} \cdot \text{CO} \\ | \\ \text{C}_3\text{H}_7 \cdot \text{CH} \cdot \text{CO} \end{array} > \text{NC}_6\text{H}_5$.

Trans-methylisopropylsuccinic acid, $\begin{array}{c} \text{CH}_3 \cdot \text{CH} \cdot \text{COOH} \\ | \\ \text{COOH} \cdot \text{CH} \cdot \text{C}_3\text{H}_7 \end{array}$, melts at 174—175°, and is much less soluble in water than the cis-acid; when distilled under diminished pressure, or when digested with acetic anhydride, it is converted into a solid anhydride melting at 46°; and this, when repeatedly distilled at ordinary pressures, is converted into the anhydride of the cis-acid.

The *anilic acid* obtained from the trans-anhydride by treatment with aniline melts at 160°, and a few degrees above this temperature loses water and is converted into the anil of the cis-acid.

The authors have also prepared the methylisopropylsuccinic acids from ethylic isopropylethanetricarboxylate, which Roser (*Annalen*, 220, 272) first synthesised by the action of ethylic α -bromisovalerate on the sodium derivative of ethylic malonate. When this ethereal salt is acted on with sodium ethoxide and methylic iodide, ethylic methylisopropylethanetricarboxylate is produced, and from this ethereal salt the methylisopropylsuccinic acids may be obtained by the method described above.

ADDITIONS TO THE LIBRARY.

I. *By Purchase.*

Carpenter, W. B. *The Microscope and its Revelations*. Seventh edition in which the first seven chapters have been entirely rewritten and the text throughout reconstructed, enlarged, and revised by the Rev. W. H. Dallinger, LL.D., F.R.S., with 21 plates and 800 wood engravings, xviii+1099 pp. London 1891. 8vo.

Redwood, Boverton, and Holloway, G. T. *Petroleum: A treatise on the geographical distribution and geological occurrence of petroleum and natural gas; the physical and chemical properties, production, and refining of petroleum and ozokerite; the characters and uses, testing, transport, and storage of petroleum products, and the legislative enactments relating thereto; together with a description of the shale oil and allied industries*. Vol. I. xxviii+1—403 pp. Vol. II. 404—900 pp. With 2 frontispieces, 15 plates, and 327 figures. London 1896. 8vo.

Rey, Jean. *Essays of Jean Rey, Doctor of Medicine: On an enquiry into the cause wherefore tin and lead increase in weight on Calcination*. (1630.) 54 pp. Edinburgh 1895. 8vo.

(Alembic Club Reprints. No. 11.)

Wiley, Harvey W. *Principles and Practice of Agricultural Analysis: A manual for the estimation of soils, fertilizers, and*

agricultural products for the use of analysts, teachers, and students of agricultural chemistry. Vol. I. Soils. x+607 pp., with 93 figures. Vol. II. Fertilizers. viii+332 pp. with 17 figures. Easton 1894-5. 8vo.

At the next meeting on Thursday, March 19th, the following papers will be read:—

“The constitution of a new acid resulting from the oxidation of tartaric acid.” By H. J. H. Fenton, M.A.

“The volume and optical relationships of the potassium, rubidium, and caesium salts of the monoclinic series of double sulphates, $R_2M(SO_4)_2 \cdot 6H_2O$.” By A. E. Tutton.

“The hydriodides of hydroxylamine.” By Professor Dunstan, F.R.S., and Ernest Goulting.

“An analysis of the water from the Dripping Well at Knaresborough, in Yorkshire.” By B. A. Burrell.

ANNIVERSARY MEETING.

The Anniversary Meeting will be held on Thursday, March 26th, at 8 p.m., when the President will deliver an address, and the election of Officers and Council for the ensuing year will take place.

PROCEEDINGS

OF THE

CHEMICAL SOCIETY.

EDITED BY THE SECRETARIES.

No. 163.

Session 1895-96.

March 19th, 1896. Mr. A. G. Vernon Harcourt, President, in the chair.

Mr. Hugh Candy was formally admitted a Fellow of the Society.

Certificates were read for the first time in favour of Messrs. W. Goodwin, 9, Westminster Gardens, Hillhead, Glasgow; Edgar Hawkins, M.D., Dudley Dispensary; Robert Haslewood Jones, 8, St. Mary's Place, Newcastle-on-Tyne; John McCrae, jun., 264, Calhoun Street, Cincinnati, Ohio; Thomas William Pilley, 33, Grove Hill Road, Denmark Hill, S.E.; Robert Barnabas Pollitt, care of Oscar Guttman, Esq., 12, Mark Lane, E.C.; Otto Rosenheim, 68, Belsize Park Gardens, N.W.; Walter Dalrymple Severn, 9, Earl's Court Square, S.W.; John Christopher Stead, 42, Grove Green Road, Leytonstone; Edward Channing Wills, Abbey Park, Keynsham, Bristol.

Of the following papers those marked * were read:—

- *37. "The constitution of a new organic acid resulting from the oxidation of tartaric acid." By Henry J. Horstman Fenton, M.A.

This paper gives an account of numerous experiments which the author has recently made with a view of investigating the constitution of the new acid, $C_4H_4O_6$, obtained by the oxidation of tartaric acid in presence of iron, which has been described in former communications.

The molecular weight, basicity, and several characteristic relationships of the acid having been already established, a choice is left between (1) the ketonic formula $\begin{array}{c} \text{CHOH} \cdot \text{COOH} \\ | \\ \text{CO} \cdot \text{COOH} \end{array}$, and (2) the dihydro-

xylic formula $\begin{array}{c} \text{C}\cdot\text{OH}\cdot\text{COOH} \\ || \\ \text{C}\cdot\text{OH}\cdot\text{COOH} \end{array}$. The acid might assume both forms, or if represented by the second formula, a fumaroid and maleinoid modification would be expected. The following is a brief summary of the principal results obtained:—

The absence of a ketonic group is demonstrated by the behaviour of phenylhydrie and of hydroxylamine. These agents have no action whatever upon the methyl and ethyl esters, and the crystalline compounds which they produce with the free acid are shown to be the respective normal salts.

The presence of *two* alcoholic hydroxyl groups is shown by the actions of acetyl chloride, benzoyl chloride, and acetic anhydride, and the unsaturated nature of the acid is indicated, directly or indirectly, by several of its reactions. These facts leave no doubt that preference must be given to the second formula, and on account of the great instability of the acid and normal aniline salts and for other reasons, it is concluded that the acid belongs to the maleic series.

By the action of hydrogen bromide in acetic acid solution, an acid is obtained which has the same composition as the original acid, and many of its properties are similar. But its crystalline form is altogether different, and its acid aniline salt shows a much greater stability in aqueous solution. It is suggested that this product may be the corresponding dihydroxyfumaric acid, the formation of which could be readily understood from two intermediate compounds which have been isolated.

*38. "The volume and optical relationships of the potassium, rubidium and caesium salts of the monoclinic series, $\text{R}_2\text{M}(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$." By A. E. Tutton, Assoc. R.C.S.

In this communication are presented the results of a detailed investigation of the physical properties of the same 22 salts whose morphological relationships were described in a former memoir (Trans., 1893, 63, 337). The main conclusions are as follows:—

1. The whole of the salts of the series exhibit a common cleavage direction parallel to the orthodome + $\{201\}$.

2. The relative density increases by an approximately constant amount for each of the two specific changes throughout the series, when potassium is replaced by rubidium, or the latter by caesium; the difference evoked by the former change is larger than that produced by the latter in the proportion of 5 : 4.

3. A similar constant increase occurs in the molecular volume, the replacement of potassium by rubidium being invariably accompanied by an increase of about 9.3 units, while the interchange of caesium

for rubidium results in the larger increase of about 13 units. The determination of the molecular volume is almost exclusively a function of the alkali metal, change of the second metal being practically unaccompanied by any change of volume.

4. The replacement of potassium by rubidium, or the latter by cæsium, is accompanied by a marked increase in the separation of the structural units along each of the axial directions. The elemental distance ratios of any rubidium salt of the series are consequently intermediate between those of the potassium and cæsium salts containing the same second metal. The effect is greatest when cæsium replaces rubidium.

5. The orientation of the variable axes of the optical indicatrix, lying in the symmetry plane, of every rubidium salt of the series is intermediate between that of the potassium and cæsium salts containing the same second metal. The replacement of rubidium by cæsium is accompanied by a much greater change of orientation than the interchange of rubidium for potassium.

6. The refractive indices of any rubidium salt of the series are without exception intermediate between those of the corresponding potassium and cæsium salts, and nearest to those of the potassium salt. An increase in the atomic weight of the contained alkali metal is accompanied by an increase of refractive power, and the increase in refraction becomes relatively greater as the atomic weight becomes higher.

7. The relative velocities of light vibration along the three axes of the optical ellipsoid of every rubidium salt of the series are intermediate between those along the corresponding directions in the analogous potassium and cæsium salts. Increase in the atomic weight of the alkali metal is accompanied by an increase of resistance to the vibrations of light waves along each ellipsoidal axis, and this alteration is much the greatest when cæsium replaces rubidium.

8. An increase in the atomic weight of the alkali metal is accompanied by convergence of the values of the velocity along the three axial directions towards unity, and consequently by a diminution in the double refraction. This property is already feeble in the potassium salts, and it is extremely weak in the cæsium salts; the rubidium salts occupy an intermediate position in this respect.

9. Cæsium nickel sulphate differs from the other salts of the series in exhibiting negative double refraction, the usual sign being positive. This fact is directly due to the operation of the preceding rule; owing to the fact that in the potassium nickel salt the two nearest of the three values of the velocity are at their maximum separation for the series, the rule of progressive convergence causes it to happen that in the cæsium salt the third value has approached

nearest the intermediate value, and this reverses the sign of double refraction. This interesting fact would have been inexplicable without the rule now established.

10. Another extraordinary result of the rule is afforded in the case of caesium magnesium sulphate, where, owing to the separation of the two nearest values of the velocity being at its minimum for the potassium salts of the series in potassium magnesium sulphate, the progressive convergence actually results in those two values arriving at unity in the caesium salt, which consequently exhibits simulated uniaxial refraction phenomena.

11. The whole of the specific and molecular optical constants, calculated by means of the formulæ of either Lorenz or Gladstone and Dale, for every rubidium salt of the series are intermediate between those of the potassium and caesium salts containing the same second metal. An increase in the atomic weight of the alkali metal is accompanied by a diminution in the specific constants and an increase in the molecular constants, the former being greatest when rubidium replaces potassium, and the latter when caesium replaces rubidium. These rules are independent of temperature.

12. Excluding the salts containing magnesium, for a reason connected with the statement in paragraph 10, the optic axial angle of every rubidium salt is intermediate between the optic axial angles of the analogous potassium and caesium salts.

13. In the magnesium salts the progressive change proceeds as usual as far as the rubidium salt, but owing to the extraordinary relations of the velocities of light vibration when the caesium salt is reached, as stated in paragraph 10, caesium magnesium sulphate exhibits specially interesting optic axial angle phenomena. The coincidence of two of the velocity values is only absolute for wave-length 450 in the blue, for which the uniaxial cross and circular rings are produced. Hence the salt exhibits very large dispersion in crossed axial planes for other wave-lengths, and great sensitiveness of the optic axial angle to change of temperature. These remarkable phenomena, almost unique as regards monoclinic symmetry, are the direct result of the rule regarding the velocity of light vibration.

14. A progressive alteration in the optic axial angle occurs upon rise of temperature, the rubidium salts being always affected in an intermediate manner.

15. So completely general are the rules given in the preceding paragraphs, that it is possible to predict the crystallographical characters of the two hitherto unprepared potassium salts of the series containing manganese and cadmium.

16. The final conclusion of the investigation is that the alkali metal R exerts a predominating influence in determining the charac-

ters of the crystals of this series, and the whole of the crystallographical properties of the potassium, rubidium, and caesium salts containing the same second metal M are, in the case of every such group throughout the series, functions of the atomic weight of the alkali metal which they contain.

- *39. "Comparison of the results of the investigations of the simple and double sulphates containing potassium, rubidium and caesium." By A. E. Tutton, Assoc. R.C.S.

The author institutes a comparison of the whole of the experimental results derived from the investigations of the rhombic simple alkaline sulphates and of the monoclinic double salts of the series $R_2M(SO_4)_2 \cdot 6H_2O$. It is shown that the whole of the morphological and physical characters of the crystals of the rhombic normal sulphates of potassium, rubidium, and caesium, and of any group of the monoclinic double sulphates of the series $R_2M(SO_4)_2 \cdot 6H_2O$, in which those simple salts of the three alkali metals are combined with the sulphates of either magnesium, zinc, iron, manganese, nickel, cobalt, copper, or cadmium, while exhibiting the same symmetry and the general similarities proper to isomorphous series, present well defined differences which are functions, and usually accelerating functions, of the atomic weight of the alkali metal which they contain.

- *40. "The bearing of the results of the investigations of the simple and double sulphates containing potassium, rubidium, and caesium upon the nature of the structural unit." By A. E. Tutton, Assoc. R.C.S.

The author arrives at the following conclusions:—(1) The absence of any considerable contraction in volume when the alkaline sulphate enters into the double sulphate, as contrasted with the relatively enormous contraction which occurs when the various atoms combine to form the chemical molecule of the alkaline sulphate, together with the facts that the double salt is only known in the solid crystallised condition, and that many of the individual members of the series are eminently unstable, render it highly improbable that there is chemical union between the molecular constituents of the double sulphates, and indicate that there is no necessity to assume linkage of any kind, but merely aggregation in accordance with such a type of homogeneous structure as ensures that they are always present in the same proportion. (2) In the production of crystals it is not necessary to suppose that any other structural units are concerned than the chemical molecules of the chemical compound in question

or of the constituent chemical compounds in the cases of double salts or salts containing water of crystallisation, and the observed fact of the constancy of molecular proportions of the two latter is entirely accounted for by the nature of the type of homogeneous structure in which they find equilibrium. (3) The pedetic or "Brownian" motion of small particles, capillarity, convection currents, or any other slightly agitating forces which assist the chemical molecules to take up this condition of equilibrium necessary for the production of a homogeneous structure, will assist crystallisation. The molecular forces whose domain of action has been shown not to extend beyond a very few molecular distances, need only be concerned in maintaining the general cohesion. (4) Considering the chemical molecule as the structural unit, in general such units will not be endowed with the same symmetry as the crystal; it may have higher, equal, or lower symmetry according to the specific constitution of the molecule. This is in complete accordance with the generalisation of Barlow concerning the homogeneous portioning of space, and the conclusion of Fock derived from the theory of solid solutions. (5) The more heterogenous the constitution of a crystallised substance, the lower in general is its type of symmetry. (6) The nature of the predominating faces, as being the planes most closely studded with similar "points," together with the directions of cleavage, agree in indicating that the type of homogeneous structure of the simple alkaline sulphates is that of the rectangular pinacoidal prism, and that of the double sulphates the primary monoclinic prism, probably type 64a of Barlow. (7) The phenomenon of the rotation of the optical ellipsoid of the double sulphates, when the atomic weight of the alkali metal is changed, is completely accounted for by the acceptance of the above simple constitution for the double salts together with the suggestion of Barlow that the orientation of the optical ellipsoid is the resultant of a process of averaging the directional retardations experienced by light waves in traversing the homogeneous structure, due to the arrangement of the molecular matter. The greater amount of rotation when caesium replaces rubidium than when the latter replaces potassium, is thus the direct result of the correspondingly greater increase of volume, largely in a particular direction, which is observed.

*41. "The hydriodides of hydroxylamine." By Wyndham R. Dunstan, F.R.S., and Ernest Goulding.

The authors have isolated two hydriodides of hydroxylamine, $(\text{NH}_3\text{O})_3\text{HI}$ and $(\text{NH}_3\text{O})_2\text{HI}$, from the interaction of methyl iodide and a solution of hydroxylamine in methyl alcohol, these salts being formed in addition to the trimethylhydroxylamine hydriodide previously de-

scribed (Proc., 1894, 138). The normal hydriodide ($\text{NH}_3\text{O}\cdot\text{HI}$) could not be found. The same hydriodides may be formed by mixing strong aqueous hydriodic acid with the calculated quantity of hydroxylamine, dissolved in methyl alcohol. Both salts crystallise well, but when recrystallised from methyl alcohol or from water, gradually lose hydroxylamine. The trihydroxylamine salt is the more stable, and may be preserved unchanged in dry air. Both salts are acid to litmus. All attempts to obtain the normal salt ($\text{NH}_3\text{O}\cdot\text{HI}$), by direct and indirect methods, have failed; its solution is very unstable and rapidly decomposes, iodine being liberated.

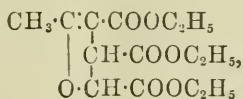
42. "An analysis of the water from the dropping well at Knaresborough, in Yorkshire." By B. A. Burrell.

The history of this remarkable spring is noticed at some length, from which it appears that its petrifying qualities were known in 1534.

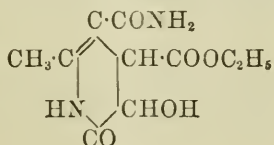
A complete analysis has now been made. The total solids amount to 162.435 grains per gallon, of which 114.37 grains are calcium sulphate, 25.48 calcium carbonate, and 17 magnesium sulphate. Traces of manganese and strontium were found.

43. "Contributions to the knowledge of ethylic acetoacetate. Part I. Acetonilmalic acid." By S. Ruhemann, Ph.D., M.A., and E. A. Tyler.

By the action of the sodium derivative of ethylic acetoacetate on ethylic chlorofumarate the authors find that the two stereoisomeric ethereal salts of the acetoacetic acids are not formed, but that in both cases one and the same compound of the formula,



is formed, which is to be regarded as ethylic methylidihydrofurfuran-tricarboxylate (b. p. $188-189^\circ$, under a pressure of 15 mm.). This constitution is supported by the chemical and physical properties of the substance. Ammonia reacts with the ethereal salt, forming a compound, which most probably has the formula,



(m. p. 195°), whilst in the hydrolysis of the furfuran derivative, brought about by alcoholic potash, acetonilmalic acid,



(m. p. 145—146°), is produced.

44. "The action of lead thiocyanate on the chlorocarbonic esters. Part I. Carboxyethylthiocarbimide and its derivatives." By Robert E. Doran.

In July, 1895, the existence of di-acidylthiocarbimides in solution was shown by Dixon and Doran (*Trans.*, **67**, 565), and the present communication contains an account of the preparation of a more highly oxidised thiocarbimide. Interaction occurs between lead thiocyanate and ethyl chlorocarbonate in accordance with the equation, $2\text{EtO}\cdot\text{CO}\cdot\text{Cl} + \text{Pb}(\text{SCN})_2 = 2\text{EtO}\cdot\text{CO}\cdot\text{NCS} + \text{PbCl}_2$, and the product was obtained by distillation under diminished pressure as a colourless highly refractive liquid, possessing a pungent fungus-like odour and the general properties of a thiocarbimide. The following derivatives were prepared and examined:—

$\text{C}_2\text{H}_5\text{O}\cdot\text{CO}\cdot\text{NH}\cdot\text{CS}\cdot\text{NH}\cdot\text{C}_6\text{H}_5$, *ab*-Carboxyethylphenylthiocarbamide, From the thiocarbimide and aniline: pure white, apparently monoclinic tables, m. p. 130°.

$\text{C}_2\text{H}_5\text{O}\cdot\text{CO}\cdot\text{NH}\cdot\text{CS}\cdot\text{NH}\cdot\text{C}_6\text{H}_5\cdot\text{CH}_3$, *ab*-carboxyethylbenzylthiocarbamide. By interaction with benzylaniline: colourless needles, m. p. 106·5—107·5°.

$\text{C}_2\text{H}_5\text{O}\cdot\text{CO}\cdot\text{NH}\cdot\text{CS}\cdot\text{NH}\cdot\text{C}_6\text{H}_5\cdot\text{CH}_3$, *ab*-carboxyethylorthotolylthiocarbamide. By interaction with *o*-toluidine: long white prisms, m. p. 152·5°.

$\text{C}_2\text{H}_5\text{O}\cdot\text{CO}\cdot\text{NH}\cdot\text{CS}\cdot\text{NH}\cdot\text{C}_6\text{H}_5\cdot\text{CH}_3$, *ab*-carboxyethylparatolylthiocarbamide. By interaction with *p*-toluidine: white, glistening, flattened prisms, m. p. 148—149°.

$\text{C}_2\text{H}_5\text{O}\cdot\text{CO}\cdot\text{NH}\cdot\text{CS}\cdot\text{NH}\cdot\text{C}_{10}\text{H}_7$, *ab*-carboxyethyl- α -naphthylthiocarbamide. By interaction with α -naphthylamic: granular prisms, m. p. 183—183·5°.

$\text{C}_2\text{H}_5\text{O}\cdot\text{CO}\cdot\text{NH}\cdot\text{CS}\cdot\text{NH}\cdot\text{C}_{10}\text{H}_7$, *ab*-carboxyethyl- β -naphthylthiocarbamide. Faintly pink plates, having a pearly lustre, m. p. 155—155·5°.

$\text{C}_2\text{H}_5\text{O}\cdot\text{CO}\cdot\text{NH}\cdot\text{CS}\cdot\text{NH}\cdot\text{C}_6\text{H}_3(\text{CH}_3)_2$, *ab*-carboxyethylmetoxylylthiocarbamide. By interaction with *m*-xylidine: pearly lozenges, m. p. 152·5—153°.

$\text{C}_2\text{H}_5\text{O}\cdot\text{CO}\cdot\text{NH}\cdot\text{CS}\cdot\text{NH}\cdot\text{C}_6\text{H}_4\text{OH}$, *ab*-carboxyethyl-*p*-hydroxyphenylthiocarbamide. By interaction with *p*-amidophenol: oblique, rhombic prisms, m. p. 198·5—199°.

$\text{C}_2\text{H}_5\text{O}\cdot\text{CO}\cdot\text{NH}\cdot\text{CS}\cdot\text{NH}\cdot\text{CH}_3$, *ab-carboxyethylmethylthiocarbamide*. By interaction with methylamine: long prisms, m. p. 119—120°.

$\text{C}_2\text{H}_5\text{O}\cdot\text{CO}\cdot\text{NH}\cdot\text{CS}\cdot\text{NH}\cdot\text{C}_2\text{H}_5$, *ab-carboxyethylethylthiocarbamide*. By interaction with ethylamine: fine oblique prisms, m. p. 79—80°.

$\text{C}_2\text{H}_5\text{O}\cdot\text{CO}\cdot\text{NH}\cdot\text{CS}\cdot\text{NH}\cdot\text{C}_4\text{H}_9$, *ab-carboxyethylisobutylthiocarbamide*. By interaction with isobutylamine: feathery tufts of needles, m. p. 53—54°.

$\text{C}_2\text{H}_5\text{O}\cdot\text{CO}\cdot\text{N}\cdot\text{C}\cdot\text{NH}_2\cdot\text{SH}$, *carboxyethylthiourea*. By interaction with ammonia: long prisms, m. p. 139—140°.

$\text{C}_2\text{H}_5\text{O}\cdot\text{CO}\cdot\text{N}\cdot\text{C}\cdot\text{N}\cdot\text{C}_6\text{H}_5\cdot\text{C}_6\text{H}_5\cdot\text{CH}_2\cdot(\text{SH})$, *carboxyethylphenylbenzylthiourea*. By interaction with benzyllaniline: long needles, m. p. 93—94°.

$\text{C}_2\text{H}_5\text{O}\cdot\text{CO}\cdot\text{N}\cdot\text{C}\cdot\text{NH}\cdot\text{C}_5\text{H}_{10}\cdot\text{SH}$, *carboxyethylpiperidylthiocarbamide*. By interaction with piperidine: fine interlaced needles, m. p. 99—99·5°.

$\text{C}_2\text{H}_5\text{O}\cdot\text{CO}\cdot\text{NH}\cdot\text{C}\begin{smallmatrix} \text{N}\cdot\text{NH}\cdot\text{C}_6\text{H}_5 \\ \text{SH} \end{smallmatrix}$, *carboxyethylphenylsemithiocarbazide*. By interaction with phenylhydrazine: fine white needles, m. p. 146·5°.

The five following esters of thiocarbamic acid were obtained by treating the corresponding alcohols with the thiocarbimide:—

$\text{C}_2\text{H}_5\text{O}\cdot\text{CO}\cdot\text{NH}\cdot\text{CS}\cdot\text{OCH}_3$, *methyl carboxyethylthiocarbamate*. Feathery tufts of needles, m. p. 65—66°.

$\text{C}_2\text{H}_5\text{O}\cdot\text{CO}\cdot\text{NH}\cdot\text{CS}\cdot\text{OC}_2\text{H}_5$, *ethyl carboxyethylthiocarbamate* (carboxyethyl- β -thiourethane). Rosettes of faintly yellow needles, m. p. 44—45°.

$\text{C}_2\text{H}_5\text{O}\cdot\text{CO}\cdot\text{NH}\cdot\text{CS}\cdot\text{OC}_3\text{H}_7$, *propyl carboxyethylthiocarbamate*. Thick yellow prisms, m. p. 31—32°.

$\text{C}_2\text{H}_5\text{O}\cdot\text{CO}\cdot\text{NH}\cdot\text{CS}\cdot\text{OC}_4\text{H}_9$, *isobutyl carboxyethylthiocarbamate*. A pale greenish-yellow liquid, which did not solidify at -8° .

$\text{C}_2\text{H}_5\text{O}\cdot\text{CO}\cdot\text{NH}\cdot\text{CS}\cdot\text{OC}_6\text{H}_5\cdot\text{CH}_2$, *benzyl carboxyethylthiocarbamate*. Tufts of white needles, m. p. 66—67°.

In the course of this investigation it is shown that the three following substances, "ethylic thioaleophanate" (Peitzsch, *Berichte*, **7**, 896), "ethylic phenylthioaleophanate" and "ethylic isophenylthioaleophanate" (Seidel, *Journ. Prakt. Chem.*, [2], **32**, 261) have been incorrectly named. The first-mentioned appears to be a pseudo-thiourea; the second an unstable equi-molecular combination of ethyl chlorocarbonate and phenylthiocarbamide; whilst the third is identical with the symmetrical carboxyethylphenylthiocarbamide obtained by the writer.

45. "An auxiliary assay balance." By Robert Law, F.I.C.

This paper describes a new form of balance applied to bullion assaying, the object of which is to give the weight of the gold

"cornet" with sufficient accuracy to enable the assayer to put the correct weight in the pan of the ordinary assay balance, and to decide the remaining fractions by means of the rider alone. This auxiliary balance is of such dimensions as to be easily accommodated in the case of the ordinary assay balance. The advantages claimed are—

1. Saving of time in weighing when gold of varying finenesses is under assay. 2. Reduction of the wear in the weights. 3. Increased life for the ordinary assay balance. 4. Avoidance of much of the concentrated attention which tends to make the assayer's work monotonous.

43. "Charas: the resin of Indian hemp." By T. B. Wood, M.A., W. T. N. Spivey, M.A., B.Sc., and T. H. Easterfield, M.A., Ph.D.

The authors have examined "charas," the exuded resin of *Cannabis indica*, with a view to the isolation of the active principle. The method adopted consisted in the fractional distillation of the ethereal extract prepared from the crude substance. By this means four compounds were isolated:—(1) A terpene, b. p. 170—180°. (2) A sesquiterpene, b. p. 258—259°, identical with that previously obtained by Valenta from Personne's "cannabene," the green oil obtained when the hemp plant is distilled with water. (3) A paraffin, probably $C_{29}H_{60}$, m. p. 63·5—64°. (4) A red oil, formula $C_{18}H_{24}O_2$, semi-solid below 60°, and boiling constantly at 265° at 20 mm. pressure; this compound is present to the extent of 33 per cent. in the sample of charas examined. In doses of 0·05 gram it produces intoxication, followed by sleep. The substance has also been isolated by the authors from a number of pharmaceutical preparations made from the plant. The resin as prepared by T. & H. Smith in 1847 contains no less than 80 per cent. of the oil. There can be no doubt that the characteristic action of Indian hemp is due to the presence of this compound, the constitution of which is under investigation.

47. "Note on the decomposition of α -chloronitrocamphor." By Arthur Lapworth, D.Sc.

It has long been known that α -bromo- and α -chloro-nitrocamphor undergo, when heated, a somewhat violent decomposition, resulting in the liberation of nitrous fumes and free halogen and the formation of products of unknown composition. The author has examined the residual mixtures, and has succeeded in obtaining, by the decomposition of α -chloronitrocamphor, some quantity of a yellow substance, which crystallises in long needles melting at 196—198°, volatilises slightly at the ordinary temperature, and yields a hydrazone melting at 169—171°. This substance proves to be identical

with the camphorquinone obtained by Claisen (*Ber.*, **22**, 530) from isonitroso-camphor. Found C = 72.1; H = 8.6. Required for $C_{10}H_{14}O_2$, C = 72.3; H = 8.4 per cent.

48. " π -Bromocamphor" By C. Revis, Assoc. C.G.Inst., and F. Stanley Kipping, Ph.D., D.Sc.

The dextrorotatory π -monobromocamphor, which was first obtained by heating camphorsulphonic bromide (Kipping and Pope, *Trans.*, **67**, 1895, 371), can be more conveniently prepared from $\alpha\pi$ -dibromocamphor (*loc. cit.*). The last named substance is readily attacked in alcoholic solution by sodium amalgam, and, under suitable conditions, the α -halogen atom only is displaced by hydrogen with formation of π -bromocamphor; the substitution of hydrogen for the α -halogen atom may also be accomplished with the aid of zinc-dust and acetic acid. The yield of the π -bromocamphor is good in both cases, but other products are also formed; the odour of camphor is very noticeable when reduction has proceeded for some time, and a crystalline substance melting at 248° has been isolated in small quantities.

This bye-product does not contain bromine, and its formation appears to be the result of condensation, an analysis having given results which point to the formula $C_{20}H_{30}O_2$. It crystallises in colourless hemimorphic prisms from dilute alcohol, and is readily soluble in chloroform, benzene, and acetic acid.

As π -bromocamphor is now obtainable in large quantities without much difficulty, its derivatives are being investigated. It is easily converted into a crystalline *oxime*, which melts at 124.5°. This oxime crystallises from dilute alcohol in colourless needles, and is readily soluble in chloroform, ethylic acetate, benzene, &c.

The study of the oxime is of particular interest, because if its chemical behaviour should prove to be analogous to that of camphoroxime—as seems to be the case—it will be possible to discuss the structural formulæ for the campholenic acids from a totally new point of view.

49. "Oxidation products of α -bromocamphorsulphonic acid." By Arthur Lapworth, D.Sc., and F. Stanley Kipping, Ph.D., D.Sc.

In the hope of obtaining a new series of oxidation products from camphor, the authors have commenced the examination of the compounds which are formed on boiling moderately concentrated nitric acid with ammonium α -bromocamphorsulphonate.

After heating during many hours, the nitric acid solution contains a small quantity of a substance which is almost insoluble in water, and is deposited in crystals on cooling and diluting. This compound

separates from acetic acid in fine, orthorhombic prisms. It melts at $188-189^{\circ}$, and is insoluble in cold dilute sodium carbonate solution; it appears to be a *sulpholactone* derived from a hydroxydibromocamphorsulphonic acid by the elimination of one molecular proportion of water. Found, $C = 31.4$, $H = 2.96$, $Br = 41.3$, $S = 8.5$ per cent. $C_{10}H_{12}SO_4Br_2$ requires $C = 30.9$, $H = 3.09$, $Br = 41.2$, $S = 8.2$ per cent.

The acid filtrate from this crystalline substance contains sulphuric acid, but in quantities which show that only a very partial elimination of the sulphonic group has occurred during the oxidation. After removing the sulphuric acid and repeatedly evaporating the filtered solution until almost free from nitric acid, there remains a thick acid syrup, from which it is very difficult to isolate the several constituents; this is owing to the fact that the product consists of hygroscopic sulphonic acids which do not lend themselves to the ordinary processes of extraction, distillation, precipitation, &c.

As the result of a number of operations, however, two crystalline substances have so far been obtained from this mixture. One of these is a sulphonic acid which crystallises from a mixture of methyl alcohol and ethylic acetate in pyramidal forms, and melts at about $156-158^{\circ}$, with evolution of gas; this compound is very readily soluble in water, from which it separates in hydrated crystals melting at $128-133^{\circ}$. Analysis of the anhydrous substance gave results agreeing with those required for a *hydroxydibromocamphorsulphonic acid*. (Found $C = 29.9$, $H = 3.8$, $Br = 38.4$, $S = 8.1$ per cent. Calculated for $C_{10}H_{14}SO_5Br_2$, $C = 29.5$, $H = 3.5$, $Br = 39.4$, $S = 7.9$ per cent.). The other compound isolated from the mixture is apparently the ammonium dihydrogen salt of a π -sulphocamphoric acid. (Found $C = 40.2$, $H = 6.4$ per cent. Calculated for $C_{10}H_{15}O_4 \cdot SO_2 \cdot ONH_4$, $C = 40.4$, $H = 6.4$ per cent.), but it requires further analysis; it separates from alcoholic ethyl acetate in microscopic plates, and is extremely soluble in water, but nearly insoluble in cold acetone.

When the crude, syrupy oxidation product is freed from water as much as possible, and then treated with phosphorus pentabromide, it yields a considerable proportion of products, which are nearly insoluble in water; from these it is easy to isolate a compound which crystallises from acetone in lustrous prisms, and decomposes at about 191° with effervescence; this substance is insoluble in cold, dilute sodium carbonate solution, and only sparingly soluble in most of the ordinary organic solvents; it seems to be a *sulphonic bromide* derived from hydroxydibromocamphorsulphonic acid.

The formation of the dibromo-derivatives described in this note must be partly attributed to the action of the bromine which is

liberated during the oxidation of some of the bromocamphorsulphonic acid to sulphocamphoric acid.

50. "On the xylic and xylidinic acids." By William Henry Bentley, and William Henry Perkin, jun.

The oxidation of pseudocumene by dilute nitric acid was first carried out by Fittig and Laubinger (*Annalen*, **151**, 257) who, by this means obtained xylic and paraxylic acids, methyl terephthalic acid, and some nitro-compounds.

The authors have found that in addition a small quantity of *methyl isophthalic acid*, $\text{CH}_3\cdot\text{C}_6\text{H}_3(\text{COOH})_2$ [$\text{CH}_3 : \text{COOH} : \text{COOH} = 1 : 2 : 4$], is produced, which is separated from its isomeride by the fractional crystallisation of the methylic salts.

Methylic methylterephthalate crystallises from the methylic alcohol in needles melting at $58-60^\circ$, while methylic methylisophthalate separates in needles melting at 73° .

The reduction products of all four acids are being studied in order to compare their properties with those of some acids obtained from camphoric acid.

Paraxylic acid, $(\text{CH}_3)_2\cdot\text{C}_6\text{H}_3\cdot\text{COOH}$ [$\text{CH}_3 : \text{CH}_3 : \text{COOH} = 1 : 2 : 4$], when reduced with sodium and amyl alcohol yields a mixture of tetra- and hexa-hydroparaxylic acid.

Tetrahydroparaxylic acid, $\text{C}_8\text{H}_{13}\cdot\text{COOH}$, crystallises from light petroleum in prisms melting at 83° and readily absorbs bromine forming a dibrom-acid, $\text{C}_8\text{H}_{13}\text{Br}_2\cdot\text{COOH}$, which melts at $121-123^\circ$.

Hexahydroparaxylic acid, $\text{C}_8\text{H}_{15}\cdot\text{COOH}$, is an oil with a disagreeable smell, boiling at 251° under a pressure of 748 mm.

Ethylic hexahydroparaxylicate, $\text{C}_8\text{H}_{15}\cdot\text{COOC}_2\text{H}_5$, is a pleasant smelling oil boiling at 224° (758 mm.). The anilide of hexahydroparaxylic acid, $\text{C}_8\text{H}_{15}\cdot\text{CO}\cdot\text{NH}\cdot\text{C}_6\text{H}_5$, separates from light petroleum in prisms melting at $113-115^\circ$.

Hexahydroparaxylic chloride, $\text{C}_8\text{H}_{15}\cdot\text{CO}\cdot\text{Cl}$, is a liquid having a disagreeable odour, boiling at 110° (25 mm.).

Ethylic bromhexahydroparaxylicate, $\text{C}_8\text{H}_{14}\text{Br}\cdot\text{COOC}_2\text{H}_5$, is a heavy liquid, boiling at $170-180^\circ$ (60 mm.).

March 26th, 1896. Anniversary Meeting. Mr. A. G. Vernon Harcourt, President, in the Chair.

The PRESIDENT commenced his address by alluding to his early connection with the Society as one of its Secretaries in 1865, when the meetings were held in the buildings of the original Burlington House, and mentioned the fact that it was during his period of office that the change to the present rooms was made. He touched upon the original intention of the Society to found a Chemical Museum, an idea ultimately abandoned; and on the use of the preparation room attached to the meeting room.

Allusion was made to the increased interest attaching to communications illustrated experimentally, and to some of the communications made during the past year which had been so illustrated.

The difficulty arising from the large number of papers now received for reading at the meetings was mentioned, and means were suggested by which this difficulty might partly be met.

The fees for composition, which were unduly low, had now been put on a proper basis.

The communications which had passed between the Council and their French neighbours and colleagues first on the occasion of M. Pasteur's death, and again on the celebration of the hundredth anniversary of the *Institut* were mentioned.

The decision of the Council to publish a Collective Index of the publications from 1873 to 1892 in two volumes was referred to, and the hope was expressed that both volumes would be delivered to the Fellows entitled to them during the coming year.

Reference was made to the private issue of lists of names calling attention to some of the candidates proposed for election. The feeling of the Council was strongly adverse to the issue of such anonymous appeals.

The arrangements for the publication of the Proceedings at the Jubilee of the Society which had been drawn up, and to a large extent completed, by Dr. Armstrong, were mentioned. The record will, it is hoped, consist of two volumes; the first of which, containing a report of the speeches made at the Jubilee meeting and at the dinner which followed, and an account of the early history and development of the Society, is all but complete. The second would consist of an account, written by Dr. Armstrong, of the scientific work of the Society during the first fifty years of its existence.

The Society has lost two of its Foreign Members, Lothar Meyer, and Pasteur. A memorial lecture in connection with the former will be delivered by Professor Bedson, on May the 28th; and arrange-

ments are in progress for the delivery of a similar address in connection with Pasteur. Reference was made to Professor Fitzgerald's address on the life and work of von Helmholtz, to the forthcoming celebrations in connection with the completion of Lord Kelvin's fiftieth year as Professor of Natural Philosophy in the University of Glasgow, and to the seventieth anniversary of the birth of Cannizzaro.

The numerical strength of the Society was as follows:—

Number of Fellows, March 31st, 1895	1979
" " since admitted	116
" " reinstated by Council	9
	<hr/>
	2104
Removed on account of non-payment of three	
annual subscriptions	28
Do. two annual subscriptions	19
Withdrawn.....	23
Deaths	15
	<hr/>
Number of Fellows, March 31st, 1896	2019
Foreign Members.....	28

It was pointed out that the action of the new bye-law under which Fellows whose last year's subscription was in arrear were removed from the register, had tended to keep down the numbers of the Society. The names of those removed were—

Three years' arrears:—Ashcroft, G. A.; Adams, F. E.; Billing, H. S.; Burnett, E. E.; Bamber, H. K. G.; Babington, P.; Byrne, Thos.; Baine, L. A.; Campbell, J. M.; Cook, Rev. E. B.; Cole, A.; Davies, D. O. S.; Foster, J. A.; King, C. M.; Kirkman, H. J.; Kacker, K. K.; Lennox, D.; Lintern, A. A.; MacLeroy, A. L.; Mousley, H. J. M.; North, W.; Quayle, E.; Stephens, C. W.; Wells, G. I. J.; Wiltshire, John; Evans, A. J.; Phipson, T. L.; Blyth, F. W. G.

Two years' arrears:—Ainsworth, Geo.; Bamber, W. E.; Chantrell, P. S.; Cooper, L.; Chaney, H. J.; Cargill, W. D.; Edmunds, Lewis; Golden, A. R.; Hope, C. F.; Jenkins, Wallis; Mansell, J.; Parker, R. H.; Speir, J.; Schlessman, J.; Tate, Dr. G.; Wilson, J. M.; Walker, D.

The following have withdrawn:—Ansell, F. G.; Briggs, H. F.; Cory, G. E.; Gardner, J.; Greenish, T.; Groves, T. B.; Haydon, W. F.; Heyes, Rev. J. F.; Holt, W.; Jackson, W.; Kay, Rev. W.; McKillop, J.; McMullan, C.; Pullinger, F.; Maben, T.; Rothwell,

R. R.; Sergeant, E.; Smith, Prof. E. F.; Stocks, J. M.; Truman, E. B.; Bose, C. M. von; Wethered, E.; Snelus, G.

The Society was fortunate in having been deprived of only 15 of its Fellows by death:—Cave, Herbert; Davy, S. H. M.; Galloway, R.; Kelly, J. A.; Liepmann, Hy.; Linford, J. S.; Looker, P.; McRoberts, G.; Morgan, Wm.; Offord, J. A.; Pochin, H. D.; Smith, C. H.; Smith, M. H.; Winstone, A. B.; Wood, John.

Twenty-two Life Members have not responded to requests for their present addresses, and it has been decided that if a renewed effort to reach them is unsuccessful their names will be removed from the register. Their names are:—Bell, P. C.; Bosanquet, R. H. M.; Brown, Prof. F. D.; Chester, E. D.; Cowie, T. R.; Crampton, Geo.; Cnstance, Prof. J. D.; Danson, J.; Edwards, J. B.; Emmons, H.; Frost, R.; Hadkinson, J.; Marsh, C. W.; Newton, H.; Strangman, J. P.; Tomlin, A.; Tookey, C.; Watson, W. H.; Williams, T.; Young, B.; Millar, James; Vacher, Arthur.

The number of communications made to the Society during the year was 163.

One hundred and sixteen papers were published in the Transactions for 1895, occupying 1172 pages, whereas in the preceding year 83 papers were published, occupying 1039 pages.

The following were the statistics relating to the Abstracts.

PART I.

	Pages.	No. of Abstracts.
Organic Chemistry	692	1190

PART II.

General and Physical Chemistry		318
Inorganic Chemistry		234
Mineralogical Chemistry		97
Physiological Chemistry.....		174
Chemistry of Vegetable Physiology and Agriculture		110
Analytical Chemistry		359
Total in Part II	544	1292
Total in Parts I and II	1236	2482

The Index to the Transactions, Proceedings, and Abstracts occupies 175 pages.

As showing the use made of the Library, it was announced that

675 volumes were borrowed from it. 134 books, 504 volumes of periodicals, and 105 pamphlets were added to the Library.

A new system of registration has been adopted, which, it is hoped, will prevent any further loss of books.

Dr. GLADSTONE, F.R.S., proposed a vote of thanks to the President, coupled with the request that he would allow his address to be printed.

Professor DIXON, F.R.S., seconded the motion, which was carried by acclamation.

The PRESIDENT having thanked the meeting,

Professor THORPE, F.R.S., the treasurer, gave an account of the balance sheet, which he laid before the Society, duly audited.

The receipts had been:—By admission fees and subscriptions, £4454; by sale of Journal and advertisements, £511 8s. 3d.; and by dividends on invested capital, £381 15s. 9d. The expenses had been:—On account of the Journal, £2858 10s. 6½d.; on account of the Proceedings, £261 6s. 2½d.; on account of the General Index, £184 2s. 6d.; on account of the Library, £306 17s. 4d.; the total expenditure being £4406 18s. 2d. Grants amounting to £180 had been made to Fellows from the Research Fund during the year.

Mr. TYRER proposed that the thanks of the Fellows be tendered to the Treasurer, for his services during the past year; this motion was seconded by Mr. D. HOWARD, and carried.

The TREASURER, in responding, proposed a vote of thanks to the auditors.

Mr. A. BLOXAM seconded the motion, which was unanimously adopted, and acknowledged by Mr. B. BLOUNT.

Dr. RUSSELL, F.R.S., proposed a vote of thanks to the Officers and Council.

Professor TILDEN, F.R.S., seconded the motion, which was unanimously adopted.

Professor THOMSON responded.

Professor McLEOD, F.R.S., proposed a vote of thanks to the Editor, Sub-Editor, and Abstractors, which was seconded by Dr. THORNE, and carried.

Mr. GROVES, F.R.S., responded.

Dr. J. Voelcker and Mr. Nagel were appointed scrutators, and a ballot was then taken for the election of Officers and Council for the ensuing year. The following were subsequently declared duly elected:—

President : A. Vernon Harcourt, M.A., LL.D., D.C.L., F.R.S.

Vice-Presidents who have filled the office of President : Sir F. A. Abel, Bart., K.C.B., D.C.L., F.R.S.; H. E. Armstrong, LL.D., Ph.D.,

F.R.S.; A. Crum Brown, D.Sc., M.D., F.R.S.; W. Crookes, F.R.S.; E. Frankland, D.C.L., F.R.S.; Sir J. H. Gilbert, Ph.D., F.R.S.; J. H. Gladstone, Ph.D., F.R.S.; H. Müller, Ph.D., F.R.S.; W. Odling, M.B., F.R.S.; W. H. Perkin, LL.D., Ph.D., F.R.S.; Lord Playfair, K.C.B., Ph.D., F.R.S.; Sir H. E. Roscoe, LL.D., F.R.S.; W. J. Russell, Ph.D., F.R.S.; A. W. Williamson, LL.D., F.R.S.

Vice-Presidents: Horace T. Brown, F.R.S.; James Dewar, M.A., LL.D., F.R.S.; Francis Robert Japp, M.A., Ph.D., LL.D., F.R.S.; Ludwig Mond, F.R.S.; W. Chandler Roberts-Austen, C.B., F.R.S.; William A. Tilden, D.Sc., F.R.S.

Secretaries: John M. Thomson; Wyndham R. Dunstan, M.A., F.R.S.

Foreign Secretary: Raphael Meldola, F.R.S.

Treasurer: T. E. Thorpe, LL.D., F.R.S.

Other Members of Council: P. Philips Bedson, D.Sc.; Bennett Hooper Brough; Bernard Dyer, D.Sc.; Otto Hehner; Herbert McLeod, F.R.S.; H. Forster Morley, M.A.; G. Harris Morris, Ph.D.; James Wylie Rodger; W. A. Shenstone; Arthur Smithells, B.Sc.; Thomas Stevenson, M.D.; Sydney Young, D.Sc., F.R.S.

ADDITIONS TO THE LIBRARY.

I. *By Purchase.*

Borchers, W. Elektro-metallurgie. Die Gewinnung der Metalle unter Vermittlung des Elektrischen Stromes. Zweite Auflage. Mit 188 Text-abbildungen. (2 folding plates.) viii+393 pp. Braunschweig. 1896. 8vo.

Lefèvre, L. Traité des Matières Colorantes Organiques Artificielles, de leur préparation industrielle, et de leurs applications. Préface de E. Grimaux. T. I. xx+832 pp. T. II. 833—1648. (With 31 new illustrations and 261 specimens of silk, wool, cotton, paper, and leather.) Paris 1896. 8vo.

Ostwald, W. The Scientific Foundations of Analytical Chemistry treated in an elementary manner. Translated, with the author's sanction, by George M'Gowan, Ph.D. xx+207 pp. London 1895. 8vo.

Richter, V. v., and Anschütz, R. Chemie der Kohlenstoffverbindungen oder Organische Chemie. Siebente Auflage. Zweiter Band. Carbocyclische und Heterocyclische Verbindungen. xviii+642 pp. Bonn 1896. 8vo.

II. *Donations.*

Rammelsberg, C. F. Handbuch der Mineralchemie. Zweites Supplement zur zweiten Auflage. viii + 475. Leipzig 1895. 8vo.

From the Author.

Risteen, A. D. Molecules and the Molecular Theory of Matter. viii + 223 pp., with 52 figures. Boston 1895. 8vo.

From the Author.

Pamphlets.

Maiden, J. H., and Smith, H. G. On a Natural Deposit of Aluminium Succinate in the Timber of *Grevillea robusta*, R. Br.

(Read before the Royal Society of N.S.W., 6th November, 1895.)

From the Authors.

Maiden, J. H., and Smith, H. G. Contributions to a Knowledge of Australian Vegetable Exudations. No. 1.

(Read before the Royal Society of N.S.W., 4th September, 1895.)

From the Authors.

NOTICE.

The Library Committee would feel obliged if Fellows who have **copies of the Bye-laws or Lists of Fellows** for 1842, or any years between that date and 1870, would lend or present them to the Library. They should be sent to the Assistant Secretary, Chemical Society, Burlington House, W.

LIST OF FELLOWS.

All changes of address intended to appear in the List of Fellows for this year should be sent at once to the Assistant Secretary.

At the next meeting, on April 23rd, the following papers will be read:—

“On the temperature of certain flames.” By Professor W. N. Hartley, F.R.S.

“Halogen additive products of substituted thiosinamines.” By Augustus E. Dixon, M.D.

“The constitution of the cereal celluloses.” By C. F. Cross, E. J. Bevan, and Claud Smith.

“An Apparatus for the detection of boric acid.” By W. M. Doherty.

“Ethereal salts of optically active malic and lactic acids.” By Prof. Purdie, F.R.S., and S. Williamson, Ph.D.

ERRATA.

Page 58, last line, *for* “platinicyanide” *read* “platinocyanide.”

Page 59, ll. 3, 9 “ “ “ “

CERTIFICATES OF CANDIDATES FOR ELECTION AT THE NEXT BALLOT.

N.B.—The names of those who sign from “General Knowledge” are printed in *italics*.

The following Candidates will be balloted for on Thursday, May 7, 1896:—

Barwise, Sidney,

The Lindens, Derby.

Medical Officer of Health of Derbyshire. Doctor of State Medicine of the University of London, D.P.H. (Cantab.), M.R.C.S. (Eng.), L.S.A. (Lond.), Fellow of the Sanitary Institute. For the M.D., in State Medicine at London I have passed four examinations in Chemistry, three being partly practical. I attended the usual courses at Mason College, Birmingham, and in Dr. Hills' Laboratory for six months. I make some 200 Analyses of Sewage Effluents and Drinking Waters each year, and publish results in Derbyshire Health Reports,

William A. Tilden.

A. L. Stern.

John C. Thresh.

James Robert Kaye.

L. Archbutt.

Durant, Henry Thomas,

C/o Messrs. Loewenstein and Co., Johannesburg, South Africa.

Chemist to Messrs. Loewenstein and Co., Manufacturing Chemists Johannesburg, South Africa. Lately Lecturer, Demonstrator, and Research Assistant to Professor Dunstan, F.R.S. Passed the Major Examination of the Pharmaceutical Society, 1893.

Wyndham R. Dunstan.

M. Carteighe.

H. A. D. Jowett.

Francis H. Carr.

Thomas S. Dymonds.

Fisher, Ernest Hunter,

The County Laboratory, St. Albans.

Analytical Chemist. For four years Senior Assistant, and now

Partner with Arthur Ekins, Public Analyst for the County of Hertford and Borough of Luton, Beds.

Arthur E. Ekins.

John Henry Baldock.

Charles H. Ashdown.

Sidney Harvey.

R. Warington.

Charles E. Cussal.

J. Kear Colwell.

Goodwin, W.,

9, Westminster Gardens, Hillhead, Glasgow.

Analyst for the British Boiler Cleaning and Enamelling Company, Glasgow. Five years study at the Owens College, Manchester, three years in Quantitative Laboratory, and two years Research. Contributed, with Professor W. H. Perkin, jun., "Cis- and Trans-hexahydro-*o*-toluic acid."

H. B. Dixon.

W. H. Perkin, jun.

Arthur Harden.

G. H. Bailey.

Edward Haworth.

Hawkins, Edgar,

Dudley Dispensary.

Doctor of Medicine. Master of Surgery (Edinburgh); Master of Arts (Oxford); Honours in Chemistry, Natural Science School, Oxford; Lecturer in Chemistry, Fetter College, 1887-92. Diploma in Public Health, Oxford.

W. W. Fisher.

C. J. Baker.

John Watts.

J. E. Marsh.

V. H. Veley.

P. Elford.

Jenkins, John Percival,

30, St. John's Road, Clifton, Bristol.

Chemist (Analytical). $5\frac{1}{2}$ years in charge of Chemical Laboratory at Messrs. Geo. Lockyer and Son, Manufacturing Chemists, Bristol. Devised the following:—(1) Tables for the estimation of Ammonia in Bone Sulphate of Ammonia from the percentage of Moisture present at 212° F. in Crystallised Salt, based on practical experiments. (2) Method for Recovery of Ammonia from Bone Water. (3) Method to prevent waste of Ammonia from Stills during the dry distillation of Bones, &c. (4) Plan for the utilisation of Bone Tar as a Liquid Fuel. (5) Compound containing high percentage of Carbon for Toughening Iron. (6) Process for the Manufacture of Prussian Blue from Waste Material. At present time engaged in investigating various waste products with a view to the economical utilisation of same. Studied Chemical Theory under A. J. Heath, Esq., B.A., F.C.S., &c., and practical work with Mr. C. E. Frank at

his Laboratory, Clifton. Attended courses of Lectures on Chemistry at University College, Bristol.

Ernest H. Cook.

Arthur J. Heath.

Alfred C. Fryer.

Arthur Richardson.

Thos. Coomber.

Sydney Young.

W. A. Shenstone.

Jones, Robert Haslewood,

8, St. Mary's Place, Newcastle-on-Tyne.

Laboratory Assistant to Messrs. Brady and Martin, Newcastle-on-Tyne. Three years Analytical Assistant in the Laboratory of Messrs. Savory and Moore, under Mr. Charles Ekin, F.I.C. Formerly Student in the School of the Pharmaceutical Society. Passed major examination of the Pharmaceutical Society 1892.

M. Carteighe.

Wyndham R. Dunstan.

Charles Ekin.

Francis Sutton.

F. Napier Sutton.

Macadam, Herbert Edwin,

Joint Works Manager, Odam's Chemical Company, Victoria Docks, E., Manufacturers of Manures, Sheep Dips, and Disinfectants. Ten years engaged in Manufacturing Chemistry as applied to home and export fertilizers and acid making in connection therewith. Also for three years in the manufacture of sheep dips and disinfectants.

Stevenson Macadam, Ph.D.

F. Napier Sutton.

C. T. Macadam.

John Hughes.

B. E. R. Newlands.

Geo. R. Morrison.

Alfred Sibson.

A. E. Sibson.

F. J. Lloyd.

McCrae, John, jun., Ph.D.,

264, Calhoun Street, Cincinnati, Ohio, U.S.A.

Instructor in Chemistry, University of Cincinnati. Student at Andersonian Technical College, Glasgow, 1891-93. Student at Heidelberg University, 1893-95. Graduate of Heidelberg University (Chemistry, Physics, and Mineralogy), 1895. Instructor in Chemistry, University of Cincinnati, 1895. Author of "Ueber die Iodonium-Basen aus *p*-Iodtoluol," *Ber.*, **28**, 97; and "Ueber Messung hoher Temperaturen mit dem Thermoelement und den Schmelzpunkt einiger anorganischer Salze," *Ann. d. Phys. und Chem.*, **55**, 95.

T. H. Norton.

G. G. Henderson.

A. Humboldt Sexton.

James Robson.

Matthew A. Parker.

Thomas Gray.

J. J. Sudborough.

D. R. Boyd.

Edmund J. Mills.

Merrett, William Henry,

Lambeth Brass and Iron Works, Short Street, Lambeth, S.E.

Assistant in the Research Laboratory of the Royal Mint. Associate of the Royal School of Mines. For some time Research Student in the Metallurgical Laboratory of the Royal College of Science. Assistant in the Metallurgical Laboratory from January to June, 1895.

W. C. Roberts Austen.

F. W. Bayley.

T. K. Rose.

William A. Tilden.

Alfred Stansfield.

Mitchell, Tom,

Cemetery House, Shaw, near Oldham.

Cemetery Registrar. Rochdale Science and Art Classes, 1887-91. Honours South Kensington (Inorganic), 1891. Lancashire County Council Scholarship, 1892. Owens College Evening Lectures and Laboratory four sessions, 1892-96.

H. B. Dixon.

Wm. A. Bone.

Bevan Lean.

Arthur Harden.

J. F. Thorpe.

G. J. Fowler.

Patterson, Joseph W.,

Avenue Road, West Hampstead.

Science Teacher. Three years Teacher and Lecturer in Chemistry under the Science and Art Department and Durham County Council. Brass Founder's Analyst (18 months). Student in Middlesborough High School, Westminster College, Durham College, and the Royal College of Science.

Jno. Archyll Jones.

George Price Dodds.

R. Phillips Bedson.

R. Greig Smith.

Saville Shaw.

Pechmann, H. von,

Tübingen, Germany.

Professor of Chemistry in the University of Tübingen. Distinguished for his Contributions to Scientific Chemistry.

Henry E. Armstrong.

Arthur Smithells.

T. E. Thorpe.

W. H. Perkin, jun.

Wyndham R. Dunstan

R. Meldola.

Pilley, Thomas William,

33, Grove Hill Road, Denmark Hill, S.E.

Demonstrator on Chemistry at St. Thomas Charterhouse School of

Science. Honours in Chemistry and seven years Demonstrator at St. Thomas Charterhouse School of Science, London.

Walter A. Voss.

Charles E. Sohn.

Arthur H. Coote.

Herbert F. Stephenson.

E. J. Read.

Pollitt, Robert Barnabas,

Care of Oscar Guttman, Esq., 12, Mark Lane, London, E.C.

Civil Engineer. Assoc.M.Inst.C.E. Assistant Manager of explosive works. Studied Chemistry at the Manchester Technical School. For the past seven years have been engaged in the manufacture of explosives, and have designed and erected works and plant for the manufacture of nitroglycerin, guncotton, cordite, dynamite, and blasting gelatine, nitric acid, chlorine, and acetone, and for the distillation of coal-tar. Since 1893 have been one of the Abstractors for the *Journal of the Society of Chemical Industry*, and have had the privilege of assisting Mr. O. Guttman in the preparation of his treatises on explosives.

Bennett H. Brough.

W. C. Roberts-Austen.

Samuel Rideal.

M. Carteighe.

W. Palmer Wynne.

George F. Holloway.

B. E. R. Newlands.

P. Gerald Sandford.

David A. Louis.

Charles E. Cassal.

Otto Hehner.

Proude, James,

13, Oak Terrace, Halifax.

Manager and Chemist at the Providence Soap Works, Halifax. Has studied Chemistry under Mr. W. Ackroyd, F.I.C. Borough Analyst for Halifax, at the Halifax Technical School, and privately under Mr. W. H. Wood, F.I.C., F.C.S., Analytical Chemist, Halifax. A Medallist in the City and Guilds Examination. Has held the above position at Providence Soap Works for nine years. Joint author of the following papers:—(1.) "On the Cause of the Change in Colour of Soaps containing Indigo Extract." (2.) "On the Solubility of Indigo in Oils" (*J. Chem. Soc. Ind.*, 1895, p. 1026). (3.) "Experiments on the Formation of the So-called Ammonium Amalgam" (*Proc. Chem. Soc.*, 1895, p. 236).

W. H. Wood.

Thos. Holgate.

Herbert W. Seely.

W. H. Richardson.

Thorp Whitaker.

C. Rawson.

Walter Leach.

F. F. Bond., M.D.

F. Percy Watson.

Herbert B. Stocks.

Reissmann, Charles H., B.A. (Camb.), B.Sc. (Lond.).

Saxony Villa, Oppidans Road, Primrose Hill, N.W.

Teacher of Chemistry. Candidate has worked for more than three years in the Laboratory of St. John's College, Cambridge. He has gained experience in Practical Organic Chemistry under Dr. Ruhemann, of Caius College, Cambridge. He is now engaged in Research Work in Physiological Chemistry at University College, London. He is a teacher of Chemistry at Channing House High School for Girls, Highgate, N., and has graduated in Chemistry at two Universities.

M. Foster.

S. Ruhemann.

William Ramsay.

G. Carey Foster.

M. M. Pattison Muir.

Renney, Henry, M.D., B.S., D.P.H. Durham.

Brookfield House, Durham Road, Sunderland.

Late Student of Chemistry and Physics at the Durham College of Science, Newcastle-on-Tyne. Studied Practical Bacteriology under Professor George Murray, Bacteriological Laboratory, College of Medicine, Newcastle-on-Tyne. Analytical Chemist. Is attached to Science and desirous of its advancement.

William Fowler.

P. Phillips Bedson.

Charles Rankin.

J. T. Dunn.

*Robert Williamson.***Robinson, Henry Fishwick, B.Sc.**

Sparthfield, Droylsden Road, Newton Heath, Manchester.

Chemist in Works of Messrs. Claus and Ree, Chemical Manufacturers. Three years in the Chemistry Department of the Owens College. First Class Honours in Chemistry, B.Sc. Victoria; Le Blanc Medal for proficiency in theory of dyeing.

Harold B. Dixon.

W. H. Perkin, jun.

Arthur Harden.

Gilbert J. Fowler.

Wm. A. Bone.

R. L. Taylor.

Jas. Grant.

Rosenheim, Otto,

68, Belsize Park Gardens, London, N.W.

Analytical and Research Chemist. Studied Chemistry under Professors E. Fischer, W. Wislicenus, A. Kekulé, A. Hantzsch, W. Gräbe, &c., at Würzburg, Bonn, Geneva. Attained the degree of Ph.D. at the university of Würzburg by examination, and on the strength of a dissertation on "Die Oxydation von *p*-Oxychinolin" (*Ber. d. d. Chem.*

Ges., 26, 1501). At present engaged in analytical and research work.

W. H. Perkin, jun.

Alfred Gordon Salamon.

Martin O. Forster.

Philip Schidrowitz.

J. S. S. Brame.

Ross, Raymond St. George,

30, Britannia Square, Worcester.

Analytical Chemist. Studied for one year at Owens College, Manchester; two years at the Dresden Polytechnic, under Dr. Hempel; two terms at the School of Brewing and Agriculture, Bavaria; two years Assistant and two years partner with Dr. Smete (Public Analyst for Worcestershire). Joint Public Analyst for the Borough of Northampton. Member of the Society of Public Analysts.

Arthur J. Cooper.

George Embrey.

C. O'Sullivan.

J. Augustus Voelcker.

E. W. Voelcker.

Severn, Walter Dalrymple, Assoc. Roy. Coll. Science (Chemistry),

9, Earl's Court Square, S.W.

Director of the West-end Pathological Laboratory, 55, Weymouth Street, Portland Place. King's College, two years. Tyne Breweries (Limited), two years. Paris (Pasteur), two weeks. Berlin (during Koch treatment), five months. Copenhagen (Hansen and Kjeldahl), three months. South Kensington, Roy. Coll. Sci., three years. This Laboratory, three years. Cambridge Laboratories, two years. Did all the experimental work in Drs. Waldo and Walsh's paper "Does Baking Sterilise Bread?" (read before the British Med. Assoc. Annual Meeting, at Bristol, 1894), *Lancet*, October 20, 1894. Joint author of *Handbook to Dr. Koch's Treatment in Tubercular Disease*, Grün and Severn. J. & A. Churchill. "Report on the Examination of the Air of 26 Public Buildings in Newcastle-on-Tyne, Chemical and Bacteriological" (North Eastern Sanitary Inspection Association). P. Philips Bedson, Thos. Watson Lovibond, and Walter D. Severn. "Method of rapidly Estimating Inversions in Sugar Wort Polarimetrically." Thos. Watson Lovibond and Walter D. Severn. Author of articles, "Bacteria," "Methods of Bacteriological Research," "The Coming Prophylaxy," "Yeasts and Mould Fungi," in *Science and Art, Saturday Review*. Am about to publish "The Significance of 'Beaded' Bacilli in Tuberculosis and Leprosy." "Comparison between the Methods of Salkowski and Haycraft for the Estimation of Uric acid."

John M. Thomson.

Percy F. Frankland.

L. Archd. Vasey.

T. F. Thorpe.

Vincent Edwards.

H. Sprengel.

Stead, John Christopher,

42, Grove Green Road, Leytonstone.

Pharmaceutical Chemist Works Manager. Some time Assistant Chemist in the laboratories of Messrs. Savory and Moore, New Bond Street; now Chemist and Manager, Mitre Works, Cordova Road, Bow, E.

Chas Ekin. F.I.C., F.C.S.

Edward H. Harrison.

John C. Umney.

*Benj. H. Paul.**Thomas Tyrer.***Tuckett, James Edward Shum, M.A. Cambridge,**

13, Hyde Road, Eastbourne.

Principal Science Master at Eastbourne College. Late Scholar Gonville and Caius College, Cambridge. 25th Wrangler Mathematical Tripos, 1892. Second Class Natural Science Tripos, 1893. Studied Chemistry in the Laboratory, Caius College, and in the University Laboratory. Formerly Principal Mathematical Master, Christ College, Brecon. At present Principal Natural Science Master at Eastbourne College.

M. M. Pattison Muir.

R. S. Morrell.

S. Rahemann.

A. Hutchinson.

*Charles T. Heycock.***Wills, Edward Chaning,**

Abbey Park, Keynsham, Bristol.

Director Messrs W. D. and H. O. Wills, Limited (Tobacco Manufacturers, Bristol and London). M.A. Cantab. Chemistry and Physics at B.A. Interested in the Chemistry connected with the tobacco manufactory. Student for the purpose of taking F.I.C. examination at the Clifton Laboratory, under Dr. E. H. Cook.

Ernest H. Cook.

Alfred E. Fletcher.

Sydney Young.

W. A. Shenstone.

F. Wallis Stoddart.

*Charles T. Heycock.**Thos. Coomber.***Wolfenden, John Hy.,**

226, Ashton Road, Failsworth, Manchester.

Science Teacher. Associate of the Royal College of Science, London (Chemistry, 1st Class). B.Sc. London (Honours in Chemistry). Teacher of Chemistry, Central School, Manchester.

T. E. Thorpe.

W. Palmer Wynne.

Chapman Jones.

J. W. Rodger.

A. E. Tutton.

R. L. Taylor.

PROCEEDINGS

OF THE

CHEMICAL SOCIETY.

EDITED BY THE SECRETARIES.

No. 164.

Session 1895-96.

April 23rd, 1896. Mr. A. G. Vernon Harcourt, President, in the Chair.

Messrs. J. W. Helps, B. Bernard Turner, C. Edward Sage, were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. Robert Addie, Langloan Iron Works, Coatbridge, N.B.; Samuel William Allworthy, M.A., 32, Lonsdale Terrace, Belfast; John Caley, 41, Norfolk Street, Beverley Road, Hull; Charles Matthew Crossman, B.Sc., 23, Euston Buildings, N.W.; Ralph Hamilton Hanger, Riverslea, Stoneferry, Hull; William Arthur Finch Lethbridge, Ivy Cottage, St. David's, Exeter; Cecil Rudolf Lidgely, 43, Marmora Road, Honor Oak, S.E.; William McConnell, jun., 25, Percy Gardens, Tynemouth; James Stanley Muir, 27, Huntley Gardens, Glasgow; James Haddon Overton, 15, West Street, Banbury; Hastings Montagu Page, Poona; Arthur Payne, 12, Victoria Square, Newcastle-on-Tyne; George Egerton Scott Smith, 67, Surrey Street, Sheffield.

The Rev. E. B. Cook and Mr. H. G. Bamber having paid their subscriptions which were in arrear, remain Fellows of the Society.

Of the following papers those marked * were read:—

- *51. "The constitution of the cereal celluloses." By C. F. Cross,
E. J. Bevan, and Claud Smith.

The general bearings of the subject, of which this is a special part, have been dealt with in previous communications (Trans., 65, 472; 67, 433; *Ber.*, 1893, 2520; 1894, 1061; 1895, 1940 and 2604; *J. Amer. Chem. Soc.*, 1896, 8).

It is now shown that the cereal celluloses may be resolved by acids into soluble derivatives of their furfuroid constituents, leaving a residue of a normal cellulose, and a process has been devised which sharply effects this separation.

Two methods of hydrolysis have been studied (1) treatment with acids of the series, $\text{H}_2\text{SO}_4 \cdot 2\text{H}_2\text{O} - \text{H}_2\text{SO}_4 \cdot 3\text{H}_2\text{O}$, in the cold, dilution and filtration from reprecipitated cellulose, the furfuroid remaining in solution; (2) treatment with dilute sulphuric acid, 1 to 2 per cent. strength, at 1 to 9 atmos. steam pressure. The best results are obtained on short heating (15 mins.) at 3 atmos. The furfuroid is then obtained quantitatively.

From a study of composition, capric reduction, yields of furfural, yields, composition, and properties of osazones, and certain special oxidations, it is concluded that the furfuroid in question is a pentose-monoformal, $\text{C}_5\text{H}_5\text{O}_3 < \overset{\text{O}}{\text{O}} > \text{CH}_2$.

Such a compound, having the empirical formula of a normal cellulose, could arise within a cellulose complex by transformation of the terminal. CH_2OH , of a hexose molecule; *i.e.*, an oxidation by internal rearrangement. The formaldehyde residue thus produced is not split off, but remains united by oxygen with the pentose residue which is simultaneously produced.

***52. "On a new compound of cobalt, and a rapid method of detecting cobalt in presence of nickel." By R. G. Durrant.**

The author shows that if excess of sodium or potassium bicarbonate is added to a solution of any salt of cobalt, and then hydrogen peroxide, a green liquid is formed.

This liquid appears to contain a cobaltate or cobaltic acid, H_2CoO_4 , for, although the substance has not at present been isolated, volumetric determinations show that the maximum green colour is reached when the molecular proportions of the cobalt salt and hydrogen peroxide are as 1 : 2; a probable reaction is $\text{CoCO}_3 + 2\text{H}_2\text{O}_2 = \text{H}_2\text{CoO}_4 + \text{CO}_2 + \text{H}_2\text{O}$.

The green solution may be formed in presence of nickel salts, and the reaction serves as a ready method both of detecting cobalt, even in presence of large excess of nickel, and of detecting nickel in presence of considerable excess of cobalt.

***53. "Ethereal salts of optically active malic and lactic acids." By Thomas Purdie, F.R.S., and Sidney Williamson, Ph.D.**

J. Wallace Walker (Trans., 1895, 67, 914) has shown that the rotations of the ethereal salts of active lactic acid are much greater when prepared by the action of alkyl iodide on silver lactate, than by

the direct action of acid on alcohol in presence of a mineral acid. To see if the same holds good in the cases of the other oxy-acids, the authors have prepared the ethereal salts of malic acid through the silver salt, and have compared the rotations of the salts thus obtained with the rotations of the same salts prepared from the alcohol. In every case the salts prepared from the silver salt were found to have the higher rotation.

The same result was evident on comparing the rotation of ethylic lactate prepared by the different methods. On the other hand, ethylic acetylmalates, prepared by the two methods, were found to have nearly the same rotation. A similar result was observed in the case of ethylic acetylactate.

The ethereal salts of both malic and lactic acids prepared from the alcohols were examined for racemoid compounds, but the quantity found was not sufficient to account for the low activity; this, coupled with the fact of the constancy of the activity of the ethereal salts prepared with the aid of mineral acids by various observers and the similarity in rotation of the acidyl compounds from ethers from both sources, lead the authors to think that some other explanation of the difference of activity of the ethereal salts prepared by the two methods must be found than the supposition that the mineral acids cause racemisation.

In examining dextro-ethylic chloropropionate prepared from lævo-ethylic lactate for the presence of racemised salt by converting it into zinc lactate, it was found that the optical activity of the recovered salt was opposite to that of the zinc lactate from which the chloropropionate was derived. The active lactic acid had undergone inversion by the action of phosphorus pentachloride, as Walden (*Ber.*, 1896, 29, 133) has recently noticed in the case of the malic acids.

54. "Metadichlorobenzene." By Frederick D. Chattaway, M.A., and R. C. T. Evans.

Metadichlorobenzene, although well known, is extremely costly and difficult to procure, and no directions for preparing it in quantity are available. The authors, having required large quantities of this compound for an investigation of some derivatives of benzene, have worked out a simple and very satisfactory method for obtaining it easily in bulk.

Acetanilide, dissolved in hot acetic acid, is treated with a thin paste of bleaching powder until two hydrogen atoms occupying the meta-positions with respect to one another are replaced successively by chlorine and a heavy liquid addition product of hypochlorous acid, and the 1 : 3 : 4-dichloroacetanilide is formed. On cooling,

this sinks, is readily separated, and when treated with hot alcohol rapidly decomposes, 1 : 3 : 4-dichloroacetanilide crystallising out. The dichloroacetanilide is then heated with strong sulphuric acid, which hydrolyses it, and on pouring the solution over ice, 1 : 3 : 4-dichloroaniline separates. The dichloroaniline, dissolved in a large quantity of alcohol, is then mixed with an excess of hydrochloric acid and diazotised by sodium nitrite, when, as the temperature rises from the reaction, the diazo-group first formed is replaced by hydrogen.

The yield of 1 : 3 : 4-dichloroaniline is nearly quantitative, and that of the metadichlorobenzene over 50 per cent. of the weight of acetanilide taken.

55. "On the temperature of certain flames." By W. N. Hartley, F.R.S.

The author, having for many years past studied the nature of flames and the spectra they emit, found no practicable means of measuring their temperature, owing to the disproportionate size of the measuring instrument (a thermo-electric couple for instance), compared with the effective volume of the flame. He measured the temperature of flames by means of gold-leaf and with fine wires of platinum $1/3000$ in. diameter, such as were drawn by Wollaston and used by Faraday, also with pure platinum wire $1/1000$ in. thick. He furnishes evidence of the high temperature of a candle flame, not only from the melting of gold and of platinum in the flame, but by an examination of the spectrum to be seen in the mantle. Experiments made with platinum wires heated in a bats-wing gas flame are described, which proved that the carbon does not lower the melting point of the platinum, at any rate in any appreciable degree. A small carbon monoxide flame melts platinum wire $1/1000$ in. in thickness, and a cyanogen flame was shown to be intensely hot, for it melted such wire with extreme ease. The author believes that his experiments have dissipated the doubt that was cast on Professor Smithells' statement of the high temperature of the mantle of the Bunsen flame, and confirm his own estimate of the high temperature of the Bessemer flame.

56. "The determination of the composition of a white sou by a method of spectrographic analysis." By W. N. Hartley, F.R.S.

It is not long since among current coin in France there were sous of a peculiar golden-yellow colour which were termed "white." It was supposed that they were made during the French Revolution of 1798 from any metal which could be readily appropriated, and great doubt expressed as to their composition.

To analyse the coin without injury, the method of photographing its spectrum was resorted to. The metals present being first ascer-

tained, their relative proportions were subsequently arrived at by comparing the photograph with a series of quantitative spectra, in which solutions of known strengths yield spectra with a certain number of lines of definite length and strength. When the composition of the coin within certain limits had been thus ascertained, alloys were made to imitate the metal and photographs of these were taken.

The third trial produced an alloy, the spark spectrum of which yielded a photograph identical with that of the coin, and its composition was found by the usual methods of analysis to be

Lead	13.93 per cent.
Copper	72.35 „
Iron	0.85 „
Zinc	12.70 „
	<hr/>
	99.83

The alloy is thus seen to be a kind of brass, in which lead takes the place of about one-half the zinc. It is also richer in copper. The coin does not ring, and its edges show signs of being cracked, which may be readily accounted for by the large proportion of lead which enters into its composition.

By the method of analysis here described, it may be advantageous and interesting to determine the composition of antique jewellery and coins, as no injury results from the action of the spark.

57. "Halogen additive products of substituted thiosinamines." By Augustus E. Dixon, M.D.

It has been recently shown by the author (*Trans.*, 1896, **69**, 17) that the "thiosinamine dibromide" obtained by Maly (*Zeit. f. Chem.*, 1867, 42) from bromine and allylthiourea is the hydrobromide of a penthiazoline derivative, probably $\text{CHBr} \begin{smallmatrix} \text{CH}_2 \cdot \text{S} \\ \text{CH}_2 \cdot \text{N} \end{smallmatrix} \gg \text{C} \cdot \text{NH}_2$; and is, moreover, identical with the substance produced by combining dibromopropylthiocarbimide with ammonia. This thiocarbimide unites readily with primary and secondary amines, yielding analogous compounds. The author has lately been engaged in experiments on the production of these compounds from bromine and substituted allylic thiocarbamides. Only the phenyl and orthotolyl derivatives had been tried, the former unsuccessfully, when an abstract appeared, in the last issue of the Society's Journal, of a paper by Gadamer (*Arch. Pharm.*, **233**, 646), showing that the addition compounds can be satisfactorily obtained from substituted allylic thiocarbamides (thiosinamines) containing fatty (methyl) groups.

An examination of Gadamer's "methylallylthiocarbamide dibromide," $C_5H_{10}N_2S, Br_2$, shows it to be saline in nature; it is, in fact, the hydrobromide of a base ($C_5H_9N_2SBr$), which is liberated on treatment of the aqueous solution with dilute alkali. The same compound, $C_5H_9N_2SBr, EBr$, is formed by mixing alcoholic solutions of dibromopropylthiocarbimide and methylamine; the author, therefore, on the grounds set forth in the paper first mentioned, regards the base as $CHBr < \begin{smallmatrix} CH_2 \cdot S \\ CH_2 \cdot N \end{smallmatrix} > C \cdot NH \cdot Me$, μ -methyl- γ -brompenthiazoline.

By analogy, it is suggested that the dimethylallylthiocarbamide dibromide, obtained by Gadamer from $CSN_2H(CH_3)_2C_3H_5$ and bromine, is probably also the hydrobromide of a dimethylated penthiazoline $CHBr < \begin{smallmatrix} CH_2 \cdot S \\ CH_2 \cdot N \end{smallmatrix} > C \cdot N(CH_3)_2$.

58. "Acidic thiocarbimides, thioureas, and ureas." By Augustus E. Dixon, M.D.

The method of preparing acidylthiocarbimides by heating the corresponding acid chlorides, dissolved in anhydrous benzene, with lead thiocyanate (Dixon and Doran, *Trans.*, 1895, 565; Dixon, *ibid.*, 1040), has now been applied to the chlorides of propionic, isobutyric, and phenylacetic acids, the yields of dissolved thiocarbimide so obtained varying from 90 per cent. of the theoretical to a nearly quantitative amount. The products are pale yellowish in colour, have a characteristic, pungent, and tear-exciting odour, and are decomposed by heating with water, with formation of thiocyanic acid; they give the ordinary thiocarbimidic reaction (desulphurisation) when warmed with ammoniacal silver or alkaline lead solution, and unite spontaneously with primary and secondary amines, yielding acid substituted thiocarbamides or thioureas; the former dissolve readily in dilute caustic alkali, exchanging the acid radicle for hydrogen. When treated in boiling alcoholic solution with silver nitrate, they exchange sulphur for oxygen, thereby affording the corresponding (acidic) ureas.

The following substances are described.

ab-Propionylphenylthiocarbamide, $EtCO \cdot NH \cdot CS \cdot NHPh$.—Brilliant, colourless prisms, m. p. $129-130^\circ$, undecomposed. With silver nitrate, it furnishes $EtCO \cdot NH \cdot CO \cdot NHPh$, identical with the compound obtained by Kühn (*Ber.*, 17, 2881) from phenylisocyanate and propionamide. *ab*-Propionylorthotolylthiocarbamide.—Hair-like needles, m. p. $143-144^\circ$. *ab*-Propionylmetatolylthiocarbamide.—Long, vitreous prisms, m. p. $86-87^\circ$. *ab*-Propionylparatolylthiocarbamide.—White needles, m. p. $127.5-128.5^\circ$. *n*-Propionyl-*p*-methylphenylthiourea, $EtCO \cdot N \cdot C(SH) \cdot NMePh$.—Large, vitreous prisms, m. p. $68-69^\circ$.

n-Propionyl-*v*-phenylbenzylthiourea.—Thick prisms, m. p. 102—103°. *a*-Propionyl- β -phenylthiosemicarbazide, $\text{EtCO}\cdot\text{NH}\cdot\text{C}\equiv\text{N}\cdot\text{NH}\cdot\text{NH}\cdot\text{C}_6\text{H}_5$.—Obtained from propionylthiocarbimide and phenylhydrazine; tufts of brilliant white prisms, m. p. 155—156°. *ab*-Isobutyrylphenylthiocarbamide, $\text{Me}_2\text{CH}\cdot\text{CO}\cdot\text{NH}\cdot\text{CS}\cdot\text{NHPh}$.—Large, colourless prisms, m. p. 128·5—129·5°. With silver nitrate it affords the urea, $\text{Me}_2\text{CH}\cdot\text{CO}\cdot\text{NH}\cdot\text{CO}\cdot\text{NHPh}$, identical with that obtained by Pinner (*Imidoäther*, 124) from butenyldiphenyldiureide and acetic acid. *ab*-Isobutyrylorthotolylthiocarbamide.—Short, white needles, m. p. 136—137°. The urea, $\text{Me}_2\text{CH}\cdot\text{CO}\cdot\text{NH}\cdot\text{CO}\cdot\text{NH}\cdot\text{To}$, forms long, flexible, satiny needles, melting at 134—135°. *ab*-Isobutyrylparatolylthiocarbamide.—Large, ice-like prisms, m. p. 134—135°. The urea crystallises from alcohol in shining needles, melting at 137—138°. *ab*-Isobutyryl α phanaphthylthiocarbamide.—Fine needles, m. p. 167·5—168·5°.

Phenacetylthiocarbimide, $\text{PhCH}_2\cdot\text{CO}\cdot\text{NCS}$, has a feeble odour, and attacks the eyes only slightly. By combination with aniline it affords $\text{PhCH}_2\cdot\text{CO}\cdot\text{NH}\cdot\text{CS}\cdot\text{NHPh}$. *ab*-Phenacetylphenylthiocarbamide.—Lustrous, white prisms, m. p. 109—110°. The corresponding urea forms thin, white needles, melting at 168—169°. *ab*-Phenacetylorthotolylthiocarbamide.—Vitreous prisms, m. p. 149—150°. With nitrate of silver it gives the urea; silky, flexible needles, m. p. 161·5—162°. *ab*-Phenacetylparatolylthiocarbamide crystallises from alcohol in brilliant, rhombic plates, melting at 150—151°. The urea occurs in hair-like needles, of m. p. 189—189·5°. $\text{PhCH}_2\cdot\text{CO}\cdot\text{N}\cdot\text{C}(\text{SH})\cdot\text{NPhBz}$, *n*-phenacetyl-*v*-phenylbenzylthiourea.—Microscopic prisms, m. p. 127·5—128·5°.

All the compounds enumerated above are insoluble, or nearly so, in water; the disubstituted thiocarbamides are all desulphurised by warming with alkaline lead tartrate, or by ammoniacal silver nitrate in the cold; the trisubstitution derivatives, on the contrary, do not give up their sulphur under these conditions.

Attempts made to obtain from picryl chloride, using either lead or mercuric thiocyanate, the corresponding picrylthiocarbimide, $\text{C}_6\text{H}_2(\text{NO}_2)_3\cdot\text{NCS}$, were unsuccessful. Experiments on the chlorides of phenylsulphonic and ethylsulphuric acids are now in progress.

59. "Apparatus for the detection of boric acid." By W. M. Doherty, Government Laboratory, New South Wales.

The milk, wine, or other substance is made slightly alkaline with sodium carbonate, and after drying, it is thoroughly charred, not burned to an ash. The charred mass is extracted with boiling water, and the solution obtained made acid with hydrochloric acid, and

evaporated gently over the water bath in a small porcelain boat, which is placed in an apparatus of the following description.

A piece of glass tubing, about 9 in. long and $\frac{1}{2}$ in. in diameter, is turned over at right angles at one end and drawn to a fine aperture. A second piece of tubing about $2\frac{1}{2}$ in. long, and a $\frac{1}{4}$ in. in bore is provided with a hole in the side, and placed over the aperture and arranged so as to form a glass Bunsen burner.

The porcelain boat or other vessel containing the properly prepared substance, supposed to contain the boric acid, is placed in the larger tube, which is attached at the wide end to the gas supply, the whole being supported by a clamp. The gas is regulated so as to produce a clear flame about $\frac{1}{2}$ in. long, and free from luminosity at the extremity of the upright tube. The vicinity of the porcelain boat is heated by an ordinary Bunsen burner, and if boric acid be present, even in the most minute quantity, the small flame will show it distinctly. It will be found desirable to apply the heat gently, increasing it slowly, and carefully observing the flame in the meantime.

LOTHAR MEYER MEMORIAL LECTURE.

The Lothar Meyer Memorial Lecture will be delivered by Professor P. Phillips Bedson, D.Sc., at an extra meeting of the Society on Thursday, May 28th, at 8 P.M.

At the next meeting, May 7th, there will be a ballot for the election of Fellows, and the following papers will be read :—

“Luteolin,” Part II. By A. G. Perkin.

“Morin,” Part I. By Bablich Hermann, Ph.D., and A. G. Perkin.

PROCEEDINGS

OF THE

CHEMICAL SOCIETY.

EDITED BY THE SECRETARIES.

No. 165.

Session 1895-96.

May 7th, 1896. Mr. A. G. Vernon Harcourt, President, in the Chair.

Certificates were read for the first time in favour of Messrs. Llewellyn John Davies, 8, Wordsworth Avenue, Cardiff; Frederick William Harris, 62, Rectory Road, Burnley; John Burnett Knight, Bushwood, Wanstead, Essex; Percy Sykes Marshall, Church School House, Lockwood, Huddersfield; Loxley Meggitt, The Laurels, St. John's Street, Mansfield; Sigmund Georgjewitsch Rosenblum, 19, Russell Road, Kensington; Douglas Stuart Spens Stewart, 9, Thistle Grove, Fulham Road, S.W.; James Whitehead, Roach Place, Rochdale.

The following were duly elected Fellows of the Society:—Henry Thomas Durant, Ernest Hunter Fisher, W. Goodwin, Edgar Hawkins, John Percival Jenkins, Robert Hazlewood Jones, Herbert Edwin Macadam, John McCrae, jun., William Henry Merrett, Joseph W. Patterson, H. von Pechmann, Thomas William Pilley, Robert Barnabas Pollitt, James Proude, Charles H. Reissmann, Henry Fishwick Robinson, Otto Rosenheim, Raymond St. George Ross, Walter Dalrymple Severn, John Christopher Stead, James Edward Shum Tuckett, Edward Channing Wills, John Henry Wolfenden.

Of the following papers those marked * were read:—

*60. "Carbon dioxide, its volumetric determination." By W. H. Symons and F. R. Stephens.

After reviewing the various methods for estimating carbon dioxide in air, the authors describe one which they find to be reliable and at the same time convenient.

For collecting the samples of air they use flasks from which all air has been expelled by means of steam, their vacuity being ascertained by weighing before and after use. For absorbing the carbon dioxide, mixed solutions of sodium hydroxide and barium chloride are used. The pressure of the sample of air in the flask is made equal to the atmospheric pressure by admitting a measured volume of air free from carbon dioxide, and the true volume is found by calculation; thus the pressure, and temperature at the time of taking the sample need not be noted. The residual hydroxide is titrated, without being removed from the flask, with dilute acetic acid and phenolphthaleïn.

The use of the same flask for collecting and cultivating micro-organisms, estimating albuminoid ammonia and oxygen absorbing matter, is suggested, and it is pointed out that the carbon dioxide may be estimated in the same sample of air, provided the number of organisms is not sufficient to influence the results through the carbon dioxide they produce.

Examples of the trustworthy nature of the process are given; in some cases carefully measured volumes of carbon dioxide have been estimated; in others, a series of samples have been taken from a closed space occupied by the authors. A compound pipette for accurately measuring volumes of gas or liquids is also described.

*61. "On certain views concerning the condition of the dissolved substance in solutions of sodium sulphate." By R. F. D'Arcy, M.A.

The differences in the solubilities of anhydrous sodium sulphate and its two well-defined hydrates, and the existence of a maximum solubility of the decahydrate at a temperature just below that at which it breaks up in the solid state into anhydrous salt and water, are properties which have been thought to indicate that these substances dissolve as such.

Other facts have been shown to be in accordance with the view that the condition of the dissolved salt is the same in all cases—the differences in solubilities being explained as being determined by the condition of the undissolved solid in contact with the liquid.

The experiments described were undertaken with the object of finding if any evidence in favour of the former, and now rather discredited, theory could be obtained by making careful experiments on the viscosities of strong solutions of this salt, prepared in different ways and at different temperatures. The results obtained are in accordance with the view of the identity of the condition of the dissolved substance in all cases.

The experimental method, which differs in some respects from those used in other researches, is believed to give results which are free from ambiguity.

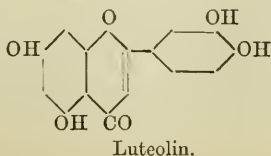
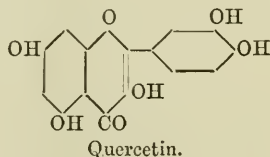
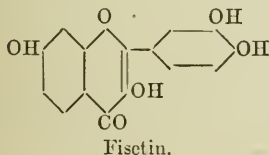
*62. "Luteolin. II." By A. G. Perkin.

In a previous communication (Trans., 1896, 69, 206), it was shown that the formula of luteolin is $C_{15}H_{10}O_6$, a fact determined by means of its compounds with mineral acids and with bromine. The production of its tetracetyl and benzoyl compounds proved it to contain four hydroxyl groups, and on methylation it yielded a product containing three methoxy-groups. Since the publication of this paper, Herzig (*Ber.*, 29, 6, 1013) has stated that he is also working upon luteolin. He mentions the methyl ether of the acetyl compound, and the decomposition of luteolin with fused alkalis. It is now shown that the product previously described, m. p. 210° , which, together with protocathechuic acid is formed by the action of fused alkalis upon luteolin, which did not then appear to be phloroglucol, is really this substance, as surmised by Herzig (*loc. cit.*).

On ethylation, luteolin yields a triethyl ether, $C_{15}H_7O_6(OC_2H_5)_3$, (yellow needles, m. p. $131-132^\circ$), insoluble in alkalis, which gives a monacetyl derivative, $C_{15}H_6O_6(OC_2H_5)_3 \cdot C_2H_5O$ (colourless needles, m. p. $185-186^\circ$). Decomposed by alcoholic potash this ether yields a crystalline yellow potassium salt, which is resolved by water into the free ether. These reactions prove that the hydroxyl group in luteolin which resists ethylation is in the ortho-position to a carbonyl group.

When heated with alcoholic potash to $130-140^\circ$, luteolin triethyl ether yields the diethylether of protocathechuic acid, and a small quantity of a substance which gives the phloroglucol reaction. The product of the methylation of luteolin (*loc. cit.*) closely resembles the ethyl ether in its reaction, as it contains three methoxy-groups, yields an acetyl compound, m. p. $174-175^\circ$, and a yellow potassium salt. Herzig (*loc. cit.*) gives the melting point of acetyl-luteolin $225-227^\circ$, but an examination of the melting point previously obtained, $213-215^\circ$, shows that this must be considered as correct.

A close resemblance of luteolin to quercetin and fisetin is traced, and it is considered that quercetin, which is an hydroxyfisetin, is most probably also an hydroxyluteolin.



*63. "Morin. Part I." By Hermann Bablich, Ph.D., and Arthur George Perkin.

The yellow colouring matter, morin, exists, as has been known for some time in old fustic (*Morus tinctoria*), and has lately been shown by one of us and F. Cope (Trans., 1895, 937) to be also contained in the Indian dyestuff, Jackwood (*Artocarpus integrifolia*). By means of its compounds with mineral acids the true formula of morin was established by one of us and L. Pate (Trans., 1895, 67, 644) to be $C_{15}H_{10}O_7$.

The principal reactions of morin described by previous workers are its behaviour towards alkaline reducing agents (Hlasiwetz and Pfaundler, *Jahres.*, 1864, 537), by which means it yields phloroglucol and β -resorecylic acid, and towards fused alkali, when it gives phloroglucol and resorcinol. Of the substitution products of morin but three are described, viz., morinsulphonic acid, $C_{15}H_9O_7HSO_3$ (Benedikt and Hazura, *Monatsh.*, 5, 167), tetrabromomorin, $C_{15}H_5Br_4O_7$, and tetrabromomorinethyl ether, $C_{15}H_5Br_4O_7 \cdot C_2H_5$. The latter is formed by brominating morin in alcoholic solution, and can be converted into tetrabromomorin by means of zinc chloride and fuming hydrochloric acid.

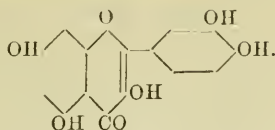
The action of fused alkalis and of bromine upon morin has been investigated, and it is shown that by the former means at 150–160° phloroglucol and β -resorecylic acid are the principal products, and with the latter the results of Benedikt and Hazura have been confirmed. Incidentally it has been found that, by the action of bromine on morin in presence of acetic acid, a considerably increased yield of tetrabromomorin is obtained.

On acetylation, tetrabromomorin yields pentacetyltetrabromomorin, $C_{15}HBr_4O_7(C_2H_3O)_5$ (colourless needles, m. p. 192–193°), from which it is evident that morin contains five hydroxyl groups. The principal product of the methylation of morin is a tetramethyl ether, $C_{15}H_5O_5(OCH_3)_4$ (light yellow needles, m. p. 131–132°). This substance is insoluble in alkalis, but yields a monacetyl derivative, $C_{15}H_5O_3(OCH_3)_4 \cdot C_2H_3O$ (colourless needles, m. p. 167°), and a crystalline yellow potassium salt, which is decomposed by water, regenerating the ether. When digested with alcoholic potash at 150–160°, the tetramethyl ether yields the dimethyl ether of β -resorecylic acid (m. p. 107–108°) and a small quantity of a product which gave the phloroglucol reaction. Morin dimethyl ether, $C_{15}H_5O_5(OCH_3)_2$, forms yellow needles melting at 225–227°.

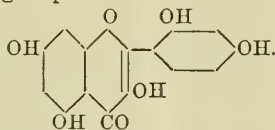
These results demonstrate a close similarity between quercetin and morin, for both contain five hydroxyl groups, one in the ortho-position to a carbonyl group, and both combine with mineral acids. Quercetin

yields with fused alkali phloroglucol and protocatechuic acid, morin, phloroglucol and β -resorcylic acid.

The formula of quercetin appears to be (Herzig, *Ber.*, 1895, **28**, 293)—



and it seems most probable that the formula of morin is represented by that of quercetin, in which the catechol nucleus has been displaced by a resorcinol group thus—



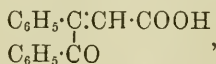
64. "Synthesis of pentacarbon rings. Part I. Anhydracetonebenzil and its homologues." By Francis R. Japp, F.R.S., and G. Druce Lander, B.Sc.

Anhydracetonebenzil, which is obtained by the condensation of benzil with acetone, was first prepared and investigated by Japp and Miller (*Trans.*, 1885, **47**, 27), and was afterwards further studied by Japp and Burton (*Trans.*, 1887, **51**, 420). In both of these earlier communications the opinion was expressed that in the condensation a closed chain of carbon atoms was formed.

The authors now show that the compound is a *diphenylhydroxycyclopentenone* of the formula

$$\begin{array}{c} \text{C}_6\text{H}_5 \cdot \text{C} \text{---} \text{CH} \\ | \qquad \qquad \qquad \diagup \\ \text{C}_6\text{H}_5 \cdot \text{C}(\text{OH}) \cdot \text{CH}_2 > \text{CO}. \end{array}$$

By oxidation with sodium hypobromite it gives an almost quantitative yield of Japp and Davidson's *desyleneacetic acid*,



a reaction which constitutes the best means at present known of preparing this compound, and at the same time proves the configuration

of the acid to be

$$\begin{array}{c} \text{H} \cdot \text{C} \cdot \text{COOH} \\ || \\ \text{C}_6\text{H}_5 \cdot \text{C} \cdot \text{CO} \cdot \text{C}_6\text{H}_5 \end{array}$$

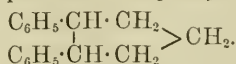
The oxidation of anhydracetonebenzil by heating it with chromium trioxide in acetic acid solution was studied by Japp and Miller (*loc. cit.*). They thus obtained a product to which they assigned the constitution of a β -benzoylhydrocinnamic (desylacetic) acid. Desylacetic acid has, however, been since prepared by Victor Meyer and Oelkers. The present authors find that the two substances are quite distinct.

They also find that Japp and Miller's acid is not the primary product of oxidation, for, when the process is conducted in the cold, simultaneous oxidation and hydration occur, and *diphenyldihydroxyglutaric acid*, $\text{C}_6\text{H}_5\cdot\overset{\text{C}(\text{OH})}{\underset{\text{C}(\text{OH})}{\text{C}}}\cdot\text{CH}_2\cdot\text{COOH}$ (m. p. 120° , when rapidly heated), is formed. On heating this acid for some time at 100° it decomposes, parting with carbon dioxide and water, and yielding Japp and Miller's acid, which has the formula of an *isocinnamenylmandelic acid*, $\text{C}_6\text{H}_5\cdot\overset{\text{C}(\text{OH})}{\underset{\text{C}(\text{OH})}{\text{C}}}\cdot\text{CH}_2\cdot\text{COOH}$, and which melts at $159\text{--}160^\circ$. (The melting point, 152° , given by Japp and Miller is too low.) When boiled with fuming hydriodic acid, or with fuming hydrochloric acid, diphenyldihydroxyglutaric acid also parts with carbon dioxide and water; but the carbon dioxide is in this case furnished by the other carboxyl group, and *desylacetic acid*, $\text{C}_6\text{H}_5\cdot\overset{\text{CH}\cdot\text{CH}_2\cdot\text{COOH}}{\underset{\text{C}}{\text{C}}}$ (m. p. 162°), is formed. Beyond the close approximation of the melting points, there is hardly any resemblance, either physical or chemical, between these two isomerides, desylacetic acid and isocinnamenylmandelic acid.

By partial reduction of isocinnamenylmandelic acid by boiling it for a few minutes with hydriodic acid, it is converted into *isophenethylmandelic acid*, $\text{C}_6\text{H}_5\cdot\overset{\text{CH}\cdot\text{CH}_3}{\underset{\text{C}(\text{OH})}{\text{C}}}\cdot\text{COOH}$ (m. p. $134\text{--}136^\circ$).

By partial reduction of anhydracetonebenzil with hydriodic acid, Japp and Burton obtained a compound, $\text{C}_{17}\text{H}_{14}\text{O}$, melting at 110° , which yielded a hydrazone, and therefore contained the original carbonyl group of the anhydracetonebenzil. The authors show that this reduction compound has the formula of a *diphenylcyclopentenone*, $\text{C}_6\text{H}_5\cdot\overset{\text{C}\cdot\text{CH}_2}{\underset{\text{C}\cdot\text{CH}_2}{\text{C}}} > \text{CO}$. That the foregoing change in the position of the double bonds has taken place during the reduction is shown by the fact that the compound yields, on oxidation with sodium hypobromite, diphenylmaleic acid, which, when liberated from its salts, changes into the very characteristic anhydride, $\text{C}_6\text{H}_5\cdot\overset{\text{C}\cdot\text{CO}}{\underset{\text{C}\cdot\text{CO}}{\text{C}}} > \text{O}$ (m. p. 156°).

The hydrocarbon, $\text{C}_{17}\text{H}_{14}$ (m. p. 47°), obtained by Japp and Burton by the complete reduction of anhydracetonebenzil with hydriodic acid and amorphous phosphorus is a *diphenylcyclopentane*,

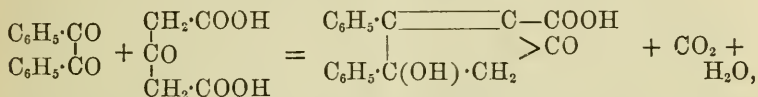


The various compounds obtained by Japp and Burton (Trans,

1887, 51, 431) by the condensation of benzil with homologues of acetone of the general formulæ $\text{CH}_2\text{R}'\cdot\text{CO}\cdot\text{CH}_3$ and $\text{CH}_2\text{R}'\cdot\text{CO}\cdot\text{CH}_2\text{R}'$ must be regarded as homologues of anhydracetonebenzil.

65. "Synthesis of pentacarbon rings. Part II. Condensation of benzil with acetonedicarboxylic acid." By Francis R. Japp, F.R.S., and G. Druce Lander, B.Sc.

Benzil and acetonedicarboxylic acid, when gently warmed with dilute alcoholic potash, condense according to the equation



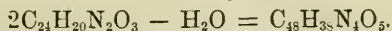
yielding *anhydracetonebenzilcarboxylic acid* (m. p. 167—168°), which corresponds with isophenanthroxyleneacetoacetic acid (Japp and Klingemann, Trans., 1891, 59, 2).

When anhydracetonebenzilcarboxylic acid is boiled for a few minutes with fuming hydriodic acid, it is reduced, simultaneously parting with carbon dioxide and yielding a *diphenylcyclopentenone* (m. p. 110°), identical with that obtained from anhydracetonebenzil itself (see preceding note).

By oxidation with sodium hypobromite, anhydracetonebenzilcarboxylic acid yields a mixture of *diphenylmaleic* and *diphenylfumaric acids*, these two substances being produced in approximately equal quantity. A change in the position of the double bonds takes place during this process.

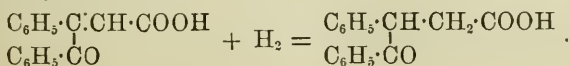
When oxidised with chromium trioxide in acetic acid solution it parts with 2 atoms of hydrogen, yielding an acid of the formula $\text{C}_{15}\text{H}_{22}\text{O}_4$ (m. p. 201°, with decomposition).

The action of phenylhydrazine is complex. The primary product is a yellow compound, apparently the hydrazone; but this readily changes, especially on recrystallisation, into dark red needles of a substance melting indefinitely above 200°, formed by elimination of 1 mol. of water from 2 mols. of the hydrazone,



66. "Reduction of desyleneacetic acid, and the constitution of Zinin's pyroamaric acid." By Francis R. Japp, F.R.S., and G. Druce Lander, B.Sc.

The authors find that by the action of zinc dust and acetic acid on desyleneacetic acid the latter is converted into Victor Meyer and Oelkers's *desylacetic acid*,



By the limited action of sodium amalgam on an aqueous solution of sodium desyleneacetate the same product is obtained. Excess of sodium amalgam, however, carries the reduction further, and $\beta\gamma$ -diphenyl- γ -hydroxybutyric acid, $\text{C}_6\text{H}_5\cdot\text{CH}\cdot\text{CH}_2\cdot\text{COOH}$, is formed, which

when liberated from its salts, speedily changes into the lactone $\text{C}_6\text{H}_5\cdot\text{CH}\cdot\text{CH}_2\cdot\text{CO}$ (m. p. 112°).

By boiling desyleneacetic acid for four hours with hydriodic acid and amorphous phosphorus, it is converted into $\beta\gamma$ -diphenylbutyric acid, $\text{C}_6\text{H}_5\cdot\text{CH}_2\cdot\text{CH}(\text{C}_6\text{H}_5)\cdot\text{CH}_2\cdot\text{COOH}$ (m. p. $96-97^\circ$). Comparison of this substance with a specimen of *pyroamaric acid* showed that the two were identical. Pyroamaric acid was first obtained by Zinin (*Jahresbericht*, 1877, 813) by fusing amaric acid with caustic potash, and was regarded by him as an ethylbenzylbenzoic acid. Klingemann (*Annalen*, 275, 81) suggested that it might be a diphenylbutyric acid.

Incidentally it was observed that when desyleneacetic acid is boiled with aqueous caustic potash it is hydrolysed, yielding deoxybenzoin. Desylenemalonic acid is stable under these conditions.

67. "Electrolysis of potassium allo-ethylic camphorate. Part II." By James Walker, Ph.D., D.Sc., and James Henderson, B.Sc.

In addition to the compounds previously described (*Trans.*, 1895, 337) the authors have obtained from the product of electrolysis of potassium allo-ethylic camphorate, a hydrocarbon, C_8H_{14} , boiling at 120° , which is formed by the decomposition of an acid, $\text{C}_9\text{H}_{14}\text{O}_2$, on heating. This hydrocarbon is apparently identical with *laurolene* prepared from camphanic acid. A ketonic acid, $\text{C}_9\text{H}_{14}\text{O}_3$, m. p. 228° , was also isolated and investigated. The authors conclude that camphoric acid contains the complex $-\text{CH}_2\cdot\text{CH}\cdot(\text{COOH})\cdot\dot{\text{C}}(\text{COOH})$.

68. "Fluorene and acenaphthene." By W. R. Hodgkinson.

Some recent communications in the *Annalen*, by Græbe and his students, on fluorene and acenaphthene, necessitate a short notice on my part about these substances in order to maintain priority.

The author has worked at these hydrocarbons and their derivatives for the past 12 years, and in *Proc.*, 1885, 36, reference is made to previous notes on the behaviour of fluorene ($\text{C}_{13}\text{H}_{10}$) when heated alone, in air, or with oxidising agents. Lately he has associated Mr. A. H. Coote, with this work.

In the paper above quoted, it is indicated that the red substance

obtained from fluorene (and also from acenaphthene) can be separated from the hydrocarbons (there called difluoryls, $C_{26}H_{15.\alpha.\beta.\gamma}$), and that this red substance is not a simple hydrocarbon, but contains oxygen.

During the past three years a great number of results have been obtained.

One conclusion arrived at is that no red or coloured hydrocarbon is produced by the oxidation of either fluorene or acenaphthene. The coloured compounds produced, along with the doubled molecule in the case of fluorene, $C_{26}H_{15}$, (difluoryl), and the coloured substance along with acenaphthylene in the case of acenaphthene, have been obtained almost pure. It is found that not only on heating with litharge, as Behr and Van Dorp first showed, but that almost any other oxide, and even potash, soda-lime, and chalk Iceland spar, will produce coloured oxidation products from both fluorene and acenaphthene, and especially from the latter. Phenanthrene, naphthalene, and anthracene, do not act in the same manner.

On the other hand both fluorene and acenaphthene may be passed along with hydrogen, steam, or hydrogen chloride, through a red hot platinum tube without change.

The isolation of these oxidation products is a difficult matter. They are not volatile alone without decomposition, and are as soluble in the usual liquids as the hydrocarbons. Picric acid also seems to precipitate them as well as the hydrocarbons.

The ethereal and chloroform solutions of these oxidation products are highly fluorescent. The one from acenaphthene more so than that from fluorene. They form compounds with acid sulphites which are non-fluorescent. Two analyses (preps. 5 and 7) taken at random,

$$C = 80.41, H = 4.51, O = 15.08.$$

$$C = 79.89, H = 4.22, O = 15.89.$$

The coloured substance from fluorene is more difficult to obtain in quantity, or pure. The average percentage of oxygen is between 9 and 10.

Sulphur behaves like oxygen towards both these hydrocarbons, and selenium also to a lesser extent. When the hydrocarbons are heated with dry sodium thiosulphate, or with some metallic sulphides, sulphur compounds of a red or orange colour are produced. Their solutions in ether and chloroform are also fluorescent. With sulphur or selenium, hydrogen sulphide and selenide are respectively produced. In the case of fluorene a difluoryl is also produced on heating with sulphur.

Several analyses of the red compound from acenaphthene and sulphur indicate the presence of about 13.26 per cent. of sulphur.

ADDITIONS TO THE LIBRARY.

I. *By Purchase.*

Berthollet, C. L. Untersuchungen über die Gesetze der Verwandtschaft. 113 pp. Leipzig 1896. 8vo.

(Ostwald's Klassiker der Exakten Wissenschaften. 74).

Berzelius, J. J. A View of the Progress and Present State of Animal Chemistry. Translated from the Swedish by Gustavus Brunmark, D.D. viii+115 pp. London 1813. 8vo.

Bouty, M., and Jamin, M. J. Cours de Physique de L'Ecole Polytechnique. Suppl. 182 pp. Paris 1896. 8vo.

Comey, A. M. A Dictionary of Chemical Solubilities. Inorganic. xx+515 pp. London 1896. 8vo.

Classen, Dr. Alexander. Handbuch der Analytische Chemie. I Theil. Qualitative Analysis. xii+242 pp. Stuttgart 1896. 8vo.

RESEARCH FUND.

A meeting of the Research Fund Committee will be held in June. Applications for grants, accompanied by full particulars should be sent to the Secretaries before June 8th.

LOTHAR MEYER MEMORIAL LECTURE.

The Lothar Meyer Memorial Lecture will be delivered by Professor P. Phillips Bedson, D.Sc., at an extra meeting of the Society on Thursday, May 28th, at 8 P.M.

At the next meeting on May 21st, the following papers will be read:—

"The diphenylbenzenes. I. Metadiphenylbenzene." By F. D. Chattaway, M.A., and R. C. T. Evans.

"Derivatives of camphoric acid." By Dr. F. S. Kipping.

"Some substances exhibiting rotatory power both in the liquid and crystalline states." By W. J. Pope.

PROCEEDINGS
OF THE
CHEMICAL SOCIETY.
EDITED BY THE SECRETARIES.

No. 166.

Session 1895-96.

May 21st, 1896. Mr. A. G. Vernon Harcourt, President, in the Chair.

Mr. Thomas B. Case was formally admitted a Fellow of the Society.

Certificates were read for the first time in favour of Messrs. John Henry Garrett, Cheltenham; Leon Felix Goldstand, 12, Quai Anglais, St. Petersbourg; Alfred Griffiths Greenway, Llandrindod Wells, N. Wales; Ernest George Hill, Muir College, Allahabad; Joshua Arthur Hughes, Abercarn, Monmouthshire; Herbert E. Law, 1526, Vallego Street, San Francisco; Asutosh Mitra, Kashmir; Samuel Thomas Skelton, 13, Derby Street, Ramsbottom, near Manchester

Mr. J. Morrow Campbell is reinstated as a Fellow.

The following papers were read:—

*69. "The diphenylbenzenes. I. Metadiphenylbenzene." By Frederick D. Chattaway, M.A., and R. C. T. Evans.

Three isomeric diphenylbenzenes, $C_6H_4(C_6H_5)_2$, are possible, but up to the present only two compounds having this formula are known, paradiphenylbenzene, and the so-called isodiphenylbenzene. The constitution of the former is established, as it has been obtained from paradibromobenzene, and yields on oxidation paradiphenylcarboxylic acid and terephthalic acid; the constitution of the latter is still doubtful.

The authors have undertaken the synthesis of ortho- and meta-diphenylbenzene, and this paper contains an account of the first part of the investigation.

When benzene vapour is led through a red hot tube, a mixture of hydrocarbons is obtained, and from the portion distilling at temperatures near 400° paradiphenylbenzene and the so-called isodiphenylbenzene have been isolated. This latter, on oxidation, yields chiefly a mixture of benzoic, paradiphenylcarboxylic, and terephthalic acids. No conclusion as to its constitution can be drawn from this, although the fact that its monobromo-derivative yields, on oxidation, an acid which, on reduction, yields diphenylmetacarboxylic acid, shows that the phenyl groups probably occupy meta positions.

Having obtained metadichlorobenzene in large amount, the authors have synthesised from this metadiphenylbenzene, which proves to be identical with the isodiphenylbenzene obtained from benzene. The hydrocarbon was obtained by the action of melted sodium on a mixture of metadichlorobenzene and chlorobenzene dissolved in boiling xylene. It is easily separated from the other products of the action by fractional distillation.

Metadichlorobenzene appears to have very slight action on benzene in the presence of anhydrous aluminium chloride, and the hydrocarbon cannot be prepared in this way.

Metadiphenylbenzene is a colourless substance, easily dissolved by ordinary solvents, and crystallising in star-shaped groups of fine needles. It melts at 84° , and boils at about 369° under a pressure of 766 mm. Its composition and molecular weight, determined by Raoult's method, using benzene as a solvent, agree very closely with those required by the formula $C_6H_3(C_6H_5)_2$.

*70. "Derivatives of camphoric acid." By F. Stanley Kipping, Ph.D., D.Sc.

The paper contains an account of numerous derivatives of camphoric acid which have been prepared from π -bromocamphoric acid, and some of which have been briefly described in previous notes (Proc., 1895, **148**, 33; **151**, 88; **157**, 210); the formation, properties, and relation to one another of all these substances are explained on the basis of Bretz's formula for camphoric acid.

The lactonic monocarboxylic acid, $C_{10}H_{14}O_4$ (m. p. 165°), which is produced when an aqueous solution of sodium π -bromocamphorate is boiled, is derived from trans- π -hydroxycamphoric acid, $C_{10}H_{16}O_6$ (m. p. 131°), whereas the more stable isomeride (m. p. 226°) is the lactone of a cis- π -hydroxycamphoric acid, which seems not to exist except in the form of a salt. These lactonic acids are named trans- π -camphanic acid and cis- π -camphanic acid respectively, in order to recall the fact that they are isomeric with, and closely related to, the *w*-camphanic acid, which is derived from *w*-bromocamphoric acid (Trans., 1896, **69**, 61).

Trans- π -camphanic anhydride, $C_{20}H_{26}O_7$, crystallises in prisms of indefinite melting point; the isomeric *anhydride* of the *cis*-acid crystallises in plates or prisms, melting at 164—165°.

Trans- π -camphanamide, $C_9H_{13}O_2 \cdot CO \cdot NH_2$, is obtained when methylic π -bromocamphorate (m. p. 114—115°) is treated with aqueous ammonia; it crystallises from aqueous ammonia in transparent octahedra, and melts at 114—115°.

Methylic cis- π -camphanate crystallises in prisms melting at 75°. *w-Hydroxy-cis- π -camphanic acid*, $C_{10}H_{14}O_5$, prepared by oxidising *cis- π -camphanic acid* with potassium permanganate, separates from water in transparent, hydrated prisms, and melts at 264—265°.

w-acetoxy-cis- π -camphanic acid, $C_{10}H_{13}O_5(OAc)$, is formed when the hydroxy-acid is heated with acetyl chloride; it crystallises well, and melts at 123—124°.

π -acetoxycamphoric anhydride, $C_{12}H_{16}O_5$, prepared by treating *trans- π -hydroxycamphoric acid* with acetyl chloride, crystallises in monosymmetric plates, and melts at 86—87° (at 89—90° on re-heating).

When *trans- π -camphanic acid* or *π -hydroxycamphoric acid* is oxidised with nitric acid, it is converted quantitatively into a tricarboxylic acid of the composition $C_{10}H_{14}O_6$ (m. p. 196°), which is named *trans-camphotricarboxylic acid*; this substance crystallises from water in massive orthorhombic pyramids, and is extremely stable towards ordinary oxidising agents; its formation from *π -hydroxycamphoric acid* shows that the latter substance contains the group $-CH_2 \cdot OH$, and consequently the π -substituent in all these π -derivatives has displaced hydrogen from a methyl group.

trans-camphotricarboxylic anhydride, $C_{10}H_{12}O_5$, forms monosymmetric crystals and melts at 253—254°.

Two isomeric lactones are formed when *trans-camphotricarboxylic acid* is treated with bromine and amorphous phosphorus at 100° and the product then warmed with water; these compounds have the composition $C_{10}H_{12}O_6$, and are both derived from a *πw -dihydroxycamphotricarboxylic acid* of the composition $C_{10}H_{14}O_7$. The one (β -lactone) crystallises in six-sided plates, and melts at 220°; the other (γ -lactone) crystallises in flattened needles of indefinite melting point, and is formed from the isomeride by heating the latter with alkalis and then acidifying.

cis-camphotricarboxylic acid, $C_{10}H_{14}O_6$, is obtained as a salt when the *trans*-acid is fused with potash; it crystallises in massive transparent prisms, and has no definite melting point, owing to the ease with which it is converted into its anhydride.

cis-camphotricarboxylic anhydride, $C_{10}H_{12}O_5$, is formed when the *trans*-acid is heated alone or with concentrated sulphuric acid; it

crystallises from benzene in prisms which effloresce in the air and melt at 220° .

*71. "On some substances which exhibit rotatory power both in the liquid and crystalline states." By William Jackson Pope.

Although a very large number of organic substances are known which in the liquid or amorphous condition rotate the plane of polarisation of a polarised ray passing through them, very few crystalline substances are known which exhibit this same property; a still smaller number of substances are known which exhibit circular polarisation both in the amorphous and crystalline condition.

Substances which exhibit circular polarisation when amorphous very frequently crystallise in those crystalline sub-systems in which enantiomorphism is possible, losing during the process of crystallising the power of circularly polarising light; during crystallisation, the latter property is in some way compensated for by the crystalline structure, which has neither planes nor a centre of symmetry. The exact connection between the crystalline form and optical activity of circularly polarising substances is as yet by no means settled, and any remarkable cases of crystallisation of such active substances consequently possess great importance.

Two substances only, viz., matico camphor and rubidium tartrate, are known which possess the power of circularly polarising light in both the amorphous and crystalline states. The author now describes a third case, that of *cis*- π -camphanic acid, which crystallises in the pyramidal hexagonal system; when viewed between crossed nicols, the hexagonal optic axial picture is seen to be of the peculiar appearance characteristic of circularly polarising hexagonal crystals. The crystals are strongly pyroelectric, and are levorotatory, the specific rotation being thus of the same sign as that of the amorphous or dissolved substance.

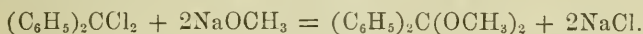
Although so few cases of the occurrence of true circular polarisation in both amorphous and crystalline states are known, a large number of optically active substances are known, the crystals of which do, in parts, exhibit circular polarisation. The latter phenomenon is, however, due to more or less complicated twinning; it is not a result of the actual molecular structure of the crystal, but of the superposition of thin laminae of the crystal. These cases should consequently not be considered as true examples of the occurrence of circular polarisation in the two states. Circular polarisation caused by the piling up of thin plates of biaxial crystals at definite angles to each other has been demonstrated by Reusch, who arranged cleavage flakes of mica one on the other in a definite sense, the optic axial planes of any piece being at 60° to those of the two

plates in contact with it; the resulting pile is uniaxial and circularly polarising. A very beautiful example of this kind of circular polarisation is found in the hydrated crystals of the optically active trans-camphotricarboxylic acid (see preceding paper); this substance crystallises in six-sided plates which simulate hexagonal symmetry, but are really composed of six sectors of an orthorhombic crystal. At the edges of the plates, where no overlapping of the sectors occurs, the biaxial interference figure of the orthorhombic crystal can be seen, whilst in the centre of the plate, where the sectors meet and overlap, the optic axial plane of each sector being at 60° with those of its two neighbours, a uniaxial interference figure is seen and circular polarisation is observed.

The crystals of this substance thus afford a very striking imitation of Reusch's circularly polarising piles of mica plates.

***72. "Dimethoxydiphenylmethane and some of its homologues." By John E. Mackenzie, Ph.D., B.Sc.**

This compound was prepared by the action of sodium methylate on benzophenone chloride according to the equation



The chloride was added to the alcoholic solution of the sodium methylate, and after reaction had taken place, the whole was heated in a water bath for two hours. The substance was obtained pure by recrystallisation from alcohol, the yield being 81 per cent. of the calculated. The crystals are perfectly colourless and odourless, melt at 106.5 — 107° and boil at 288 — 290° without decomposition. They are easily soluble in ether, hot methyl and ethyl alcohols, and benzene, but less so in the cold, insoluble in water. The substance is volatile with steam. It is unaffected by alkalis, but is decomposed by acids, forming benzophenone. In a desiccator over sulphuric acid it loses ether.

Diethoxydiphenylmethane $(\text{C}_6\text{H}_5)_2\text{C}(\text{OC}_2\text{H}_5)_2$ is prepared similarly. Yield 85 per cent. of the calculated. The colourless crystals melt at 51.5 — 52° . The solubility and general behaviour are similar to the methoxy-compound.

Dibenzoxydiphenylmethane $(\text{C}_6\text{H}_5)_2\text{C}(\text{OC}_7\text{H}_7)_2$ is prepared similarly, except that the mixture of chloride and the sodium derivative of the alcohol is heated to 205 — 210° . The crystals melt at 104 — 105° , and decompose when distilled. They deliquesce on exposure to air. They are easily dissolved by the ordinary solvents when hot, with difficulty when cold.

ADDITIONS TO THE LIBRARY.

I. *By Purchase.*

Gadolin, Axel. Abhandlung über die Herleitung aller Krystallographischer Systeme mit ihren Unterabtheilungen aus Einem Einzigem Principe. 92 pp., with 26 figures and 3 tables. Leipzig 1896. 8vo.

(Ostwald's Klassiker der Exakten Wissenschaften. 75).

Kirchoff, G., und Bunsen, R. Chemische Analyse durch Spectralbeobachtungen. 134 pp., with 2 tables and 7 figures. Leipzig 1895. 8vo.

(Ostwald's Klassiker der Exakten Wissenschaften. 72).

II. *Donations.*

Lawes, Sir John Bennet, F.R.S., and Gilbert, Sir J. Henry, F.R.S. The Rothamsted Experiments: being an Account of some of the Results of the Agricultural Investigations conducted at Rothamsted in the Field, the Feeding Shed, and the Laboratory, over a period of 50 years. viii+354 pp. London 1895. From the Authors.

Pamphlets.

Pearce, Richard. Some Notes on the Occurrence of Uraninite in Colorado.

(Read before the Colorado Scientific Society, in Denver, September 9, 1895.) From the Author.

Seyewetz, A., and Sisley, P. Chemie des Matières Colorantes Artificielles. Vol. I, viii+151 pp.; Vol. II, 153—336 pp. Paris 1896. 8vo. From the Authors.

RESEARCH FUND.

A meeting of the Research Fund Committee will be held in June. Applications for grants, accompanied by full particulars, should be sent to the Secretaries before June 8th.

At the next meeting on June 4th, the following papers will be read:—

“The magnetic rotation of organic substances with especial reference to benzenoid compounds.” By Dr. W. H. Perkin, F.R.S.

“Note on santalal and some of its derivatives.” By Alfred C. Chapman and H. E. Burgess.

“Mononitroguaiacol.” By Professor Meldola, F.R.S.

PROCEEDINGS
OF THE
CHEMICAL SOCIETY.
EDITED BY THE SECRETARIES.

No. 167.

Session 1895-96.

May 28th, 1896. EXTRA MEETING. Mr. A. G. Vernon Harcourt,
President, in the Chair.

Professor P. PHILLIPS BEDSON, M.A., D.Sc., delivered the Lothar Meyer Memorial Lecture.

After relating the more important events in the career of Lothar Meyer, his experimental work on the "Gases of the Blood" was considered, the results of which form the basis of the teaching at the present day. The history of Meyer's independent contribution to the "Periodic Law" was examined, and the development of this system of classification of the elements was traced in Meyer's writings from 1864 to the close of 1869, when he published the paper containing the well known curve of atomic weights and atomic volumes. The investigations of Meyer, undertaken with the object of promoting the systematic arrangement of inorganic chemistry, were noticed. The utilisation of Graham's determination of the rates of transpiration of gases to deduce from them the molecular volumes of gases was next considered, and a description given of the investigations by which it was sought to determine the rates of transpiration of vapours, and thus to arrive at the molecular volumes of vapours. In tracing the history of Meyer's literary work, more especially of the *Modernen Theorien*, first published in 1864, of which he was preparing a sixth edition at the time of his death, it was pointed out how great had been Meyer's influence on the promotion and advancement of chemical theory during the past 30 years.

Sir HENRY ROSCOE proposed, and Dr. GLADSTONE seconded, a vote of thanks to Professor Bedson, which was supported by Dr. RUSSELL, and carried unanimously.

June 4th, 1896. Mr. A. G. Vernon Harcourt, President, in the Chair.

Mr. J. C. Stead was formally admitted a Fellow of the Society.

Certificates were read for the first time in favour of Messrs. Walter William Cobb, Hilton House, Atherstone; Arthur Edwin Saville, 33, Richmond Terrace, Darwen; Kotaro Shimomura, Dole-machi, Kioto, Japan; John James Whimster, 12, Rutland Terrace, Stockton-on-Tees; Alfred James Wilcox, The Grammar School, Guisborough, Yorks.

The PRESIDENT announced that the following Address was to be presented to Professor Cannizzaro, a Foreign Member of the Society, on the occasion of his seventieth birthday, in July next. *

"ADDRESS TO PROFESSOR CANNIZZARO.

"On behalf of the Council and Fellows of the Chemical Society of London, we, the President and Officers, beg to offer to you, Stanislao Cannizzaro, our most sincere congratulations on the attainment of your seventieth birthday. A society such as ours, having for its object the promotion of chemical science, cannot but acknowledge that your association with us as Foreign Member since 1862, and in 1872 as our Faraday Lecturer, is a source of the greatest satisfaction to all our Fellows, and we desire, in giving expression to this sentiment, to convey to you the wish that your name may for many years continue to add lustre to the roll of our membership.

"At a critical period in the history of our science, when the conceptions of equivalence, atomic weight, atoms, and molecules were ill-defined, and when much confusion existed concerning the fundamental doctrines of chemical theory, you were the first who succeeded in directing the attention of chemists in general to the law which will ever be associated with the name of your illustrious countryman Amadeo Avogadro. Not only did you make known the importance of this law in its chemical bearings, but with the clearest perception of its far reaching consequences, you demonstrated in your masterly memoir, *Sunto di un corso di Filosofia Chimica*, published in 1858, how by its adoption the conflicting views of many of the most eminent chemists of that period could be reconciled and made harmonious. By your advocacy the law of the specific heats of the elements, enunciated by Dulong and Petit in 1819, became more firmly established as an essential principle of chemistry. Our modern methods of determining molecular weight by means of vapour density, and the interpretation of abnormal vapour densities in the

light of the theory of dissociation are the direct outcome of your labours on behalf of chemical science. The revised system of the atomic weights of the elements, which has rendered possible their rational classification in accordance with the periodic law of Newlands, Mendeléef, and Lothar Meyer, and which was necessitated by the acceptance of the hypothesis of Avogadro, has now become universally recognised.

"As one of the founders of the new chemistry, your name will live in the annals of our science as that of a man held in the highest honour and esteem—a name worthy of being joined with those of your great countrymen, Galileo, Torricelli, Volta, and Galvani.

"The congratulations which we now offer you in the name of our Society express the unanimous feeling of the chemists of this country, and not least of ourselves, the officers of the Chemical Society, who are entrusted with the honour of conveying them to you."

The following Address is to be presented to Lord Kelvin on the occasion of the completion of his fiftieth year as Professor of Natural Philosophy in the University of Glasgow.

"ADDRESS TO THE RIGHT HON. THE LORD KELVIN, D.C.L., LL.D.,
F.R.S., FROM THE CHEMICAL SOCIETY OF LONDON.

"THE Council of the Chemical Society of London desire to convey to you their sincere congratulations on the occasion of the Jubilee of your Professorship of Natural Philosophy in the University of Glasgow.

"The period during which you have occupied this Chair has been distinguished by the rapid growth of our knowledge of Nature, and the applications of this knowledge to the public good.

"In the past, great names in England and in other countries have been associated with important theoretical advances, and with technical inventions; but it has been given to few, and to none so much as to yourself, to combine a powerful grasp of the most recondite questions in Science with the ability to apply knowledge in an eminently successful manner to the service of mankind.

"With the growing perception of the dependence of one department of Science upon another, we, as Chemists, feel more and more the far-reaching applications of your contributions to Physics, and it is with gratitude and pride in your work that we to-day join with representatives of other Sciences and other nations in offering homage to one whose name will ever occupy a foremost place among the pioneers of Natural Knowledge."

Of the following papers that marked * was read:—

- *73. "On magnetic rotatory power, especially of aromatic compounds."
By W. H. Perkin, LL.D., Ph.D., F.R.S.

This paper gives an account of the apparatus used in measuring molecular rotations, at temperatures up to about 100° , also particulars concerning the determinations of boiling points and densities, with a description of the apparatus used for the latter purpose when it is necessary to determine them up to temperatures of about 100° , and also for substances which are solid at ordinary temperatures.

The results obtained on determining the rotation of mixtures of compounds where the specific rotations are wide apart, and of those where they are nearly identical are then considered, and it is seen that, under the first circumstances, rotations are obtained which are not the mean of those of the constituents of the mixture, but lower, whilst in the latter case they are the mean of the two. The most striking differences obtained are those with mixtures of ethylic nitrate and carbon disulphide.

The next subject is that of the influence of varying temperatures on the rotations. The results obtained show that all substances yet examined, water excepted, fall slightly in rotation as the temperature rises. The amount varies with different classes of substances.

This difference in the change of rotation is called the *temperature-difference*, and the results are analogous to those obtained when the refractive power of compounds is determined under similar circumstances. The rotation of water which does not fall with the density, as with other substances, evidently increases slightly with rise of temperature. This is thought to be due to the breaking down of molecular complexes.

The next section refers to the magnetic rotations of aromatic compounds, and comprises ethereal salts, mixed oxides containing phenyl and alcohol radicles, &c., phenylic salts of the fatty acids, hydrocarbons, phenols, alcohols, aldehydes, ketones, nitriles, nitro-compounds, haloid and sulphur compounds, amines, unsaturated compounds, &c.

From the results obtained with these different classes of substances it is seen that there is a great difference between the rotations of aromatic and fatty compounds, the effect of the nuclei contained in them greatly influencing the rotation.

It is found that in many cases the substances behave like double molecules, the part containing the fatty groups acting like a fatty compound, whilst that containing the nucleus acts in a different manner. This occurs more especially where a carbonyl group exists between the nucleus and the fatty groups, in which position it acts like a screen

between them. Some other groups also behave in this manner more or less effectively.

The nucleus is also influenced by the groups and haloids it is associated with, thus with nitroxyl and fluorine its influence is greatly reduced, and it is also reduced, but not to nearly so large an extent, by carbonyl and also by chlorine, all being strongly electro-negative elements and groups. On the other hand, it is much increased by association with hydrocarbon groups, especially when unsaturated, and greatly by the electro-positive amidogen group and its methylated and phenylated derivatives.

With reference to the effect produced by the nitroxyl group, it is thought that possibly the oxygen in this compound may be in a paramagnetic condition, as oxygen is when in the free state, and especially when in the liquid condition. If so, this would account for the very low rotation of this compound, as it would have a negative rotation. If this be so, the inference is that fluorine is also paramagnetic; the very low rotation of sulphuric acid and phosphoric acid, containing sulphur and phosphorus, which have very large rotations, would also become easily explainable if the oxygen they contained were paramagnetic.

The variation in the influence of the nucleus on the rotation was found to be very considerable, even in hydrocarbons, the influence increasing as two or more nuclei become more and more nearly associated, and at last come into direct union, as in diphenyl. This, however, does not appear to arise from mass action.

The effect produced by the association of the benzene nucleus with the unsaturated group $-\text{CH} = \text{CH}-$ is also found to be very remarkable, and especially so when two are united with it, one on each side, as in stilbene, the result being nearly 10 times as great as when this group is in the fatty compounds.

From the results obtained it is evident that no fixed value can be found for phenyl in hydrocarbons or other aromatic compounds, nor yet for naphthyl; at the same time the rotations do not give any constant values for the groups which are directly associated with the nucleus. Thus, the influence of NH_2 entering a paraffin raises its rotation by 0.971, but in benzene 4.792, and in naphthalene, for the α -position, 12.353. From these results it is seen that it would be absurd to assume that this group has these widely different values, or that the carbon and hydrogen in the nucleus has changed so as to share in this great increase. It is noticed also that these great changes take place in cyclic compounds only.

The fact that in naphthalene both nuclei are apparently equally affected by the introduction of nitroxyl or amidogen, although the displacement taking place in one only, suggests that there is a kind of

inductive influence going on in these compounds from one carbon to the other ; especially as the effect of some of the groups approximates to the ordinary influences found in the fatty series, multiplied by the number of carbon atoms in the nuclei, the amount being sometimes rather lower and sometimes rather higher. Taking aniline, as an example, the increase in rotation for the amidogen group in the nucleus, although not six times as great as the ordinary influence of amidogen in the fatty series, is yet nearly five times that amount. In the naphthalene series it is rather more than 10 times as great in the β -compound, whilst in the corresponding α -compound it is 12 times as great.

Diphenylamine affords an interesting example in this connection, the two separate molecules being united by NH. The influence it exerts appears to be not much less than twice that of this group in aniline, both nuclei being evidently equally influenced.

From these results it appears that these great changes in rotation must be chiefly due to physical influences, and that only a part of their effect can be attributed to the rotatory power of the atoms contained in the molecule.

The high refractive power of these compounds apparently must also be due to the physical nature of the molecules, and not simply to their chemical composition.

It is considered doubtful whether only one kind of physical condition would account for all that takes place in such compounds containing the benzene nucleus, as besides smallness and largeness of rotation, there are other differences to be accounted for.

The physical conditions due to the arrangement of the atoms in the molecules of saturated carbon compounds, being more simple than those connected with the unsaturated or cycloid compounds, have only a comparatively small influence on the rotation, yet each series of these compounds has an initial influence of its own, dependent on the series group, or special molecule, such as COOH, CO, COH, OH, &c., and for calculating the rotations of members of these different series, a set of *series constants* had to be prepared. These variations cannot evidently be due to change in the rotatory power of the elements, but must be caused by the physical conditions induced by molecular arrangement.

On considering the refractive power of saturated compounds, it is found that similar variations occur in the different series. Thus the paraffins, mono- and poly-hydroxy-compounds, or alcohols, give relatively higher results than the aldehydes, fatty oxides, and ethereal salts. Formic acid and its ethylic salt being exceptional, as in the case of the rotations.

These fluctuations in the refractions must, therefore, be real, and

not due to experimental errors, and the influences modified as in the rotation, by molecular arrangement, the so-called value used in calculations being only the average influences which the elements exert in different compounds. These must not be regarded as physical constants.

It is at present impossible to determine with certainty the relationship of these influences to the true value of the elements, especially as there are few elements suitable for examination, and even these are usually molecular groups, but the evidence, though scanty, points to the probability of the true values of the elements not being largely different from the average influence they exert in the ordinary saturated carbon compounds, though perhaps rather higher.

In saturated cyclic compounds the structure is, as might be expected, also simple, and like that of ordinary open chain compounds, because the influence of the CH_2 groups contained in both is apparently practically the same. But directly unsaturated groups occur in open chain compounds, and consequently greater molecular complexity of the molecule exists, larger rotations and higher refractive power manifest themselves, and these increase with each repetition of the unsaturated group, notwithstanding that there is a loss of H_2 , in composition each time. When, however, these unsaturated groups are united, so as to form a cyclic compound, a much greater effect is produced, both on rotation and refraction, evidently due to the formation of a new molecular system.

Considering these products from the saturated to the unsaturated, and then to the cyclic condition, each step being accompanied with a reduction of H_2 , and at the same time a rise in rotation and refraction, and then a still larger increase on the formation of the nucleus, it becomes evident that it is the increase of molecular complexity that is the cause of the augmentation of these properties, and that it is not the composition of the substance which produces the effect. It would be difficult to believe that the true rotation or refractive power of an element could be a variable quantity.

Whilst the influences given for the rotations and refractive power of the elements in the fatty series are not true values, yet this does not militate against their usefulness, as a means of judging the constitution of compounds. The same is also true of the apparent values of phenyl and the effect of other groups in the aromatic series.

74. "Mononitroguaiacol." By Raphael Meldola, F.R.S.

In the course of some investigations on phenol derivatives, not yet complete, the author had occasion to prepare mononitroguaiacol.

As this compound does not appear to have been described before, and as the author learns that other investigators are engaged on the same subject, the following note on the method of preparation may be found of use. The difficulty in nitrating guaiacol directly is to prevent the nitration going too far, so as to avoid the formation of dinitroguaiacol on the one hand, or, on the other hand, complete destruction of material. The action of nitric acid on guaiacol is rendered quite manageable by acetylating or benzoylating the compound as a preliminary step. The acetyl derivative is an oil (Tiemann and Koppe, *Ber.*, 14, 2020); the benzoyl derivative is readily formed by the action of benzoyl chloride on guaiacol in the presence of sodium hydroxide in aqueous solution. Crystallised from dilute alcohol it forms small rhombohedra, melting at 58--59°. In order to nitrate the acetyl derivative, it is mixed with about an equal volume of glacial acetic acid, and a considerable excess of fuming nitric acid is gradually added to the well-cooled mixture. It is advisable to dilute the nitric acid at first with glacial acetic acid, but the undiluted acid may subsequently be added in small portions, if the contents of the flask are not allowed to become warm. The condition essential for success may be briefly described as being rapid nitration at a low temperature; if allowed to stand too long dinitroguaiacol is formed. The great excess of nitric acid is necessary to form the mononitro-derivative rapidly. The whole operation takes from one and a half to two hours, and the completion of the nitration is best ascertained by stirring a few drops of the solution vigorously with water on a watch-glass. If the oily deposit does not solidify on being stirred with water in the course of a few minutes, more nitric acid is required; when the oily drops soon become crystalline under the conditions mentioned, the whole contents of the flask must be stirred into cold water in a thin stream, and allowed to stand for some hours. The solid mononitroguaiacol acetate is collected, washed with water, and purified by crystallisation from boiling water. The compound separates on cooling in small, whitish needles, having a melting point of 101--102°.

0.0985 gave 5.6 c.c. moist nitrogen at 13.5° and 764.8 mm. = 6.73. The formula $C_6H_3 \cdot NO_2 \cdot OCH_3 \cdot OC_2H_5O$ requires N = 6.63 per cent.

It is probable that two nitro-derivatives, an ortho- and a para-, are formed during this process, but the orthonitro-compound is present only in small quantity, and is removed by the process of crystallisation. The final product is most probably the paranitro-compound, $C_6H_3 \cdot NO_2 \cdot OCH_3 \cdot OH$ (4:2:1), for reasons that will appear subsequently. The acetyl derivative is readily hydrolysed by boiling with dilute caustic alkali for a few minutes. An orange solution of the alkaline salt of nitroguaiacol is obtained, and, on acidifying, the nitro-

guaiaecol separates out in the form of whitish, ochreous needles. After purification by crystallising from hot water, it has a melting point of 104° .

0.0732 gave 5 c.c. moist nitrogen at 12° and 771.2 mm. = 8.22. The formula $C_6H_3 \cdot NO_2 \cdot OCH_3 \cdot OH$ requires N = 8.27 per cent.

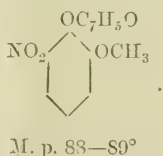
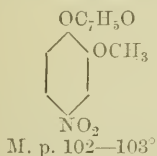
Benzoylguaiacol is nitrated in acetic acid by the same method as that described for the acetyl derivative, and, on the whole, is a more satisfactory compound to work with. The first action of the nitric acid is the formation of an oily product, which does not solidify in water, possibly a nitrate. When sufficient nitric acid has been added, the oily deposit solidifies in water, as before, but vigorous stirring on the watch-glass is necessary to promote crystallisation. The benzonitroguaiacol thus obtained consists of a mixture of two modifications, which can be separated by crystallisation from alcohol. The chief product which separates out first consists of prismatic needles, melting at $102-103^{\circ}$. The mother liquor deposits the other modification on standing, in the form of rhombic plates, which, after two or three crystallisations from alcohol, have a melting point of $88-89^{\circ}$.

0.0976 (needles) gave 4.15 c.c. moist nitrogen at 14.5° and 765.9 mm. = 5.01.

0.1078 (plates) gave 4.8 c.c. moist nitrogen at 19° and 764.1 mm. = 5.12.

The formula $C_6H_3 \cdot NO_2 \cdot OCH_3 \cdot OC_7H_5O$ requires N = 5.12 per cent.

Although no direct proof of the constitution of these two nitro-derivatives has been obtained as yet, there is every reason for believing that they are the ortho- and para-compounds.



This view, so far as relates to the para-compound, is borne out by the fact that the nitro-guaiacol of m. p. 104° obtained by the hydrolysis of the acetyl derivative of m. p. $101-102^{\circ}$, gives the same benzoyl derivative (m. p. $102-103^{\circ}$) on treatment with benzoyl chloride and alkali in the usual way. It may be pointed out that the paranitro-derivative has been prepared more especially with a view to the direct synthesis of engenol and related compounds, since the replacement of the nitro-group by halogens, and subsequently by allyl, should give rise to the formation of benzoylengenol.

In carrying out these experiments, much valuable assistance has been rendered by Mr. Edward J. Wray.

ADDITIONS TO THE LIBRARY.

I. *By Purchase.*

Ahrens, Dr. Felix B. Handbuch der Elektrochemie. Mit 281 in den text gedruckten Abbildungen. viii+540 pp. Stuttgart 1896.

Cohen, Dr. Ernst. Studien zur Chemischen Dynamik nach J. H. van't Hoff's Etudes de Dynamique Chimique. Mit einem Vorwort von Prof. Dr. J. H. van't Hoff und 49 Figuren in Text. vi+280 pp. Amsterdam and Leipzig 1896.

Grosbans, J. A. Darstellung der Physikalischen Eigenschaften der Chemischen Verbindungen $C_pH_qO_r$, als Funktion der Atomsumme oder Densitätszahl, $p+q+r$. vi+224 pp. Berlin 1895.

Mohr, F. u. Classen A. Lehrbuch der Chemisch-Analytischen Titrimethode. Siebente umgearbeitete und vermehrte Auflage. Mit 191 eingedruckten Holzstichen. xviii+906 pp. Braunschweig 1896.

Krauch, Dr. C. Die Prüfung der chemischen Reagentien auf Reinheit. Dritte, umgearbeitete und sehr vermehrte Auflage. iv+409 pp. Berlin 1896.

At the next meeting (the last meeting of the present session), on Thursday, June 18th, there will be a ballot for the election of Fellows, and the following papers will be read:—

"The action of bromine on pinene in reference to the question of its constitution." By Professor Tilden, F.R.S.

"Note on santalal and some of its derivatives." By A. C. Chapman and H. E. Burgess.

"The thermochemical peculiarities of chloral and bromal hydrates." By W. J. Pope.

"Further observations on the production of chlorine by heating a mixture of manganese dioxide and potassium chlorate." By Professor McLeod, F.R.S.

"Acetylene: its detection and ignition in the air." By Professor Clowes, D.Sc.

"The rotation of aspartic acid." By B. M. C. Marshall.

"On the occurrence of quercetin in the outer skins of the bulb of the onion (*Allium sepa*)." By A. G. Perkin and J. J. Hummel.

"On the colouring matter contained in the bark of the *Myrica nagi*." By A. G. Perkin and J. J. Hummel.

"Note on some new derivatives from camphoroxime." By Dr. M. O. Farster.

"An apparatus for showing experiments with ozone." By G. S. Newth.

CERTIFICATES OF CANDIDATES FOR ELECTION AT THE NEXT BALLOT.

N.B.—The names of those who sign from “General Knowledge” are printed in *italics*.

The following Candidates will be balloted for on Thursday, June 18th, 1896:—

Addie, Robert,

Langloan Iron Works, Coatbridge, N.B.

Metallurgical Chemist. Formerly Furnace Manager, Hallside Steel Works, Newton (Steel Company of Scotland); and formerly Chemist, Mossend Steel Works, Mossend, N.B. At present engaged in research work on Cyanides. Author of one Paper on “Chemical Phenomena of the Siemens Furnace,” published in *Engineering*; and one Paper on “Recovery of Tar and Ammonia from Blast Furnace Gases,” published in *Journal of Gas Lighting*.

Horatio Ballantyne.

John Clark.

Hugh Barclay.

Geo. Ritchie.

Archd. R. Ormiston.

Allworthy, Samuel William,

32, Lonsdale Terrace, Belfast.

Medical Profession. Master of Arts, Trinity College, Dublin University. Ekinhead Scholarship in Experimental Science (Trinity College, Dublin University). Interested in, and engaged in Chemical and Pharmacological Research.

Hugh Woods.

Robert Barklie.

A. Wynter Blyth.

Theodore Maxwell.

A. H. McConnell.

Caley, John,

41, Norfolk Street, Beverley Road, Hull.

Chemist in Oil and Manure Works. Three years Articled Pupil with Mr. Carr Robinson, F.R.S.E., F.I.C., F.C.S. 1st Class Honours Inorganic Practical Chemistry. Obtained prizes for Physiology and Hygiene. Attended Lectures on Oils, Colours, and Varnishes, also

Applied Mechanics. Have been in my present post $4\frac{1}{2}$ years, as Works and Analytical Chemist to the Hull Oil Manufacturing Co., Limited.

G. Carr Robinson.

H. Irving Foster.

Fred. E. Johnson.

James Baynes.

II. Follows.

Allan T. Hall.

Crossman, Charles Matthew,

23, Euston Buildings, N.W.

Analytical Chemist. Bachelor of Science, London University (Honours in Chemistry). Three years student in University College, London (1891-94), and subsequently with Professor Charles Graham.

Charles Graham.

William Ramsay.

J. Norman Collie.

G. Carey Foster.

Charles J. Wilson.

John F. Rolfe.

Herbert E. Burgess.

Vivian B. Lewes.

Davies, Llewellyn John,

8, Wordsworth Avenue, Cardiff.

Analytical Chemist. Three years, from 1888 to 1891, articled pupil to Mr. Thomas Hughes, Borough Analyst for Cardiff and Newport. Eighteen months, from 1891 to 1893, at the University College of South Wales and Monmouthshire, and for the past three years chief assistant to the above Mr. Thomas Hughes, in which position I am at present. Member of the Society of Chemical Industry.

Thomas Hughes.

A. A. Read.

Claude M. Thompson.

E. P. Perman.

Thomas Dyke Acland.

Garrett, John Henry,

Cheltenham.

Medical Officer of Health. Prizeman in Chemistry. A good deal of practice in Analytical Chemistry, Chemical enquiries into Action of Water on Lead, Pollution of Rivers, &c. (published), M.D., F.L.S.

John C. Thresh.

Francis T. Bond.

Alfred Hill.

William Fowler.

B. S. Gott.

Greenway, Alfred Griffiths,

Llandrindod Wells, S. Wales.

Physician, M.D., M.Ch., R.U.I. Patent for the Elimination of Phosphorous and Sulphur in Molten Iron by Electrolysis within a

Bessemer Converter during the blow for making Steel, and other patents of a chemical nature. Discoverer of a new Chalybeate Spring, at Llandrindod Wells. The inclusion of H_2S in a surface spring at Llanwyrtd Wells, S. Wales, whereby the dissolved gas was permanently increased from 4 to 10 cub. in. per gallon, as analysed by Professor Attfield.

Arthur W. Warrington.

Chas. A. MacMunn.

William P. Thompson.

William A. McCubbin, F.I.C., F.C.S.

H. Lloyd Snape.

Hanger, Ralph Hamilton,

"Riverslea," Stoneferry, Hull.

Analytical Chemist in Oil, Colour, and Varnish Works. Articled Pupil for 3 years under Mr. G. Carr-Robinson, F.R.S.E., F.I.C., F.C.S., Analytical and Consulting Chemist and Assayer. Lately Professor of Chemistry under the Corporation of Hull Technical Instruction Committee. Have attended Lectures on Oils, Colours, and Varnishes, and am now engaged as Analytical Chemist and Superintendent in Colour Striking Department of Hanger, Watson, and Harris, Limited, Stoneferry, Hull.

G. Carr Robinson.

H. Follows.

H. Irving Foster.

George H. Hurst

Fred. E. Johnson.

Harris, Frederick William,

62, Rectory Road, Burnley.

Chemist to the Burnley Corporation Gas, Water, and Sewage Departments. I was for four years an articled pupil of the late Dr. Wm. Morgan, Public Analyst for Swansea, &c.; then studied for three years at the Polytechnical School at Karlsruhe (Germany); afterwards became Assistant to Dr. Morgan, and then obtained my present appointment, which I have held for two years.

Rhys P. Charles, F.I.C.

S. W. Harris.

Arthur Luty.

W. Terrill.

Christopher James.

Hill, Ernest George,

Muir College, Allahabad.

Professor of Chemistry. Formerly Science Demy (Scholar) of Magdalen College, Oxford; B.A. 2nd Class in Chemistry, Honour School of Nat. Sci.; now Professor of Chemistry at Allahabad, India, N.W.P.

W. W. Fisher.

John Watts.

J. E. Marsh.

V. H. Veley.

J. A. Gardner.

Hughes, Joshua Arthur,

Abercarn, Monmouthshire.

Pharmaceutical Chemist. Passed Major Exam. of Pharmaceutical Society. Twelve months student under Prof. Snape and Mr. Warrington at the University College of Wales, Aberystwith; six months under Mr. Watson Will, F.C.S.; seven months studied Chemistry and Physics under T. A. Ellwood, F.I.C.; and Undergraduate of the University of London.

T. H. W. Idris.

Arthur W. Warrington.

W. Watson Will.

T. A. Ellwood.

*C. Sordes Ellis, A.I.C.***Knight, John Burnett,**

Bushwood, Wanstead, Essex.

Analyst, Messrs. Howard and Sons, Stratford. 3 years Finsbury Technical College. Assisted Prof. Perry, F.R.S., in the work for his paper "Liquid Friction" (*Phil. Mag.*, May, 1893); $2\frac{1}{2}$ years at Messrs. Howard and Sons.

R. Meldola.

David Howard.

Martin O. Forster.

Julian L. Baker.

R. C. T. Evans.

Lethbridge, William Arthur Finch,

Ivy Cottage, St. David's, Exeter.

Teacher and Lecturer in Chemistry (Pract. and Theor.). 2nd Class Honours in Natural Science Tripos, 1894, subjects being Chemistry, Physics, Geology, Mineralogy. Science Master for more than a year in schools under the Science and Art Department, and recently have become a Lecturer under the same. Stroud School of Science and Art and Marling School, Stroud. Very desirous of keeping in touch with the progress of Chemistry since leaving Cambridge.

G. H. K. Kingdon.

H. Macan.

W. J. Sell.

H. J. H. Fenton.

Alexander Scott.

Thomas H. Easterfield.

W. J. Lewis.

Lidgey, Cecil Rudolf,

43, Marmora Road, Honor Oak, S.E.

Analytical Chemist. Three years articled pupil to a Public Analyst in London. Subsequently engaged in General Metallurgical work with D. A. Sutherland, Esq., F.I.C. Have since been and at present am Assistant to J. C. Butterfield, Esq., F.I.C., of 13, Victoria Street, Westminster.

J. C. Butterfield.

A. E. Barclay.

Thomas Fairley.

D. A. Sutherland.

Robt. N. Lennox.

James Macfar.

Marshall, Percy Sykes,

Church School House, Lockwood, Huddersfield.

Public Analyst's Assistant. For the past $2\frac{1}{2}$ years sole assistant to Geo. Jarmain, Esq., F.I.C., Public Analyst for Huddersfield, previous to which underwent a 4 years course of chemical and physical training at the Huddersfield Technical School under the above mentioned Mr. Jarmain, and Dr. Turpin, M.A.

S. G. Rawson, D.Sc.

James Sykes, F.C.S.

Joe Frost, F.C.S.

G. S. Turpin, M.A., D.Sc.

L. Gordon Paul, Ph.D., F.I.C.

Thomas Fairley.

B. A. Burrell.

James Robert Kaye.

McConnell, William, junr.,

25, Percy Gardens, Tynemouth.

Brewer. Student of Chemistry at the Durham College of Science for 5 years. Obtained the A.Sc. of the University of Durham. Was awarded Royal (1851) Exhibition Scholarship in 1891, and in 1893 published in conjunction with Prof. Bedson, a Report on the Gases enclosed in Coal and Coal-dust.

P. Phillips Bedson.

F. C. Garrett.

Saville Shaw.

R. Greig Smith.

Thos. Watson Lovibond.

Meggitt, Loxley,

The Laurels, St. John's Street, Mansfield.

Analytical Chemist. Chemist to Saml. Meggitt and Sons, Limited, Glue and Manure Manufacturers, Mansfield. Associate of the Institute of Chemistry. Student for 3 years at Nottingham University College. Assistant for 9 months to Mr. A. H. Allen, F.I.C., &c., of Sheffield, assistant for 1 year to the Analyst under the Notts County Council. Analyst for 1 year under the Notts County Council.

Frank. Clowes.

J. J. Sudborough.

R. Lloyd Whiteley.

J. B. Coleman.

M. J. R. Dunstan.

Muir, James Stanley,

27, Huntly Gardens, Glasgow.

Assistant to the Professor of Chemistry, University of Glasgow. Bachelor of Science. Honours in Chemistry, 1890, Glasgow. Senior Assistant to the Professor of Chemistry.

John Clark.

John Ferguson.

G. G. Henderson.

Matthew A. Parker.

Edmund J. Mills.

Thomas Gray.

James Robson.

W. Ivison Macadam.

Overton, James Hadden,

15, West Street, Grimsbury, Banbury.

Second Master, Banbury Technical School, and Inspector for the Tech. Inst. Com., Oxford C.C. Student, Owens College, Manchester, Chemistry, &c., 1874-75. Student, Oxford University Laboratories Chemistry. Compiler "Medals and Acids." Groups, Charts, and Specimen Analyses.

H. E. Roscoe.

P. Elford.

W. W. Fisher.

A. E. Tutton.

J. E. Marsh.

Page, Hastings Montague,

Poona, Bombay Presidency.

Head Master, Government College of Science, and Ag. Scientific Botanical and Agricultural Lecturer, in charge Botanical Survey. Has held the following appointments in the Government College of Science, Poona, viz., Head Master, Demonstrator of Practical Chemistry and Geology, Ag. Profr. of Mathematics and Civil Engg., Ag. Scientific Botanical and Agricultural Lecturer, Ag. Profr. of Civil Engineering, Ag. Profr. of Chemistry and Geology. Apart from the College—Examiner in Science to the Government Agricultural High Schools, Bombay Presy. Examiner in Natural Science to the University of Bombay. In charge Botanical Survey of the Bombay Presidency.

S. Hoare Collins.

M. Kelway Bamber.

H. Couldrey.

B. Phillips.

A. Milne.

Stephen Wellington.

Payne, Arthur,

12, Victoria Square, Newcastle-on-Tyne.

Chemical Works Manager. Also engaged upon research in connection with photographic chemicals.

Joseph Wilson Swan. John Pattinson. George Price Dodds.

John Morrison.

R. Routledge.

Rosenblum, Sigmund Georgjewitsch,

19, Russell Road, Kensington, London.

Analytical Chemist. Studied Chemistry at the University of Warsaw. Student and Assistant in the Laboratory of Professor Fresenius, Wiesbaden. Managing Chemist of the Keynsham Soap Works, Bristol. Assistant to Dr. S. Rideal, 28, Victoria Street, S.W. "Chemische Analyse der Elizabeth und Victoria Quelle," Wiesbaden, 1895 (under the direction of Professor Fresenius); "The Analysis of Chrome Iron Ore, Ferrochromium, and Chrome Steel," *Jour. Soc. Chem. Ind.* (joint author, Dr. S. Rideal).

C. R. Fresenius.

Samuel Rideal.

Bennett H. Brough.

Willm. Thorp.

Robt. Steele.

Skelton, Samuel Thomas,

13, Derby Street, Ramsbottom, N. Manchester.

Analytical Chemist. Three years Assistant to Mr. J. M. Stocks, F.C.S. Am now, and have been for the past $1\frac{1}{2}$ year, Chemist to the Ramsbottom Paper Mill Company, Limited, in succession to Mr. Josh. M. Stocks.

Arthur Carey.

R. L. Taylor.

Ira Moore.

George H. Hurst.

William Dixon.

*J. T. Ainslie Walker.***Smith, George Egerton Scott,**

67, Surrey Street, Sheffield.

Analytical Chemist. Senior Assistant to Mr. A. H. Allen, Associate of the Society of Public Analysts.

Alfred H. Allen.

A. J. Cownley.

Wm. Chattaway.

B. H. Paul.

Edward Smith.

C. G. Moor.

Stewart, Douglas Stuart Spens,

9, Thistle Grove, Fulham Road, S.W.

Geologist and Mineralogist. Student at the Owens College for four years. Took Ordinary B.Sc. degree in Chemistry and Geology, and the Honours B.Sc. degree in Geology in the Victoria University. Intends to take up the subjects of Geology and Metallurgy professionally.

Harold B. Dixon.

Arthur Harden.

Bevan Lean.

P. J. Hartog.

E. Haworth.

Whitehead, James,

Roach Place, Rochdale.

Chemist to the Union Alkali Co., Manchester. Studied Chemistry under Professors Thorpe and Hummel at the Yorkshire College, Leeds.

T. E. Thorpe.

Walter M. Gardner.

Joseph Hill Heywood.

J. J. Hummel.

W. Marshall.

Approved by Council under Bye-law I (3).

Goldstand, Leon Felix,

12, Quai Anglais, St. Petersbourg.

Student of Agricultural Chemistry, Berlin. Member of the Royal

Agricultural College (by examination), and Gold Medallist of the same. Graduate in Law, Warsaw University.

Edward Kinch.

Cecil Cooke Duncan.

J. Augustus Voelcker.

Law, Herbert E.,

1526, Vallego St., San Francisco, Cal., U.S.A.

Derive my income from property. Am also interested in some Chemical Factories in San Francisco, devoting large part of my time to chemical research in my private laboratory. From private tuition, &c. Chief object for joining Chemical Society is to obtain Society's Journal, &c.

Fredk. Shapley,

Thos. W. Salter.

C. A. Buckmaster.

Mitra, Asutosh Rai Buhadur,

Kashmir.

Chief Medical Officer, Kashmir. Chemical Examiner to Kashmir Government, and Superintendent of Chemical and Physical Laboratory, Kashmir.

C. J. H. Warden, M.D.

Turaprasauna Roy.

Chuni Lal Bose.

Ramchandra Dutta.

PROCEEDINGS
OF THE
CHEMICAL SOCIETY.
EDITED BY THE SECRETARIES.

No. 168.

Session 1895-96.

June 18th, 1896. Mr. A. G. Vernon Harcourt, President, in the Chair.

Messrs. J. K. Burbridge and James Proude were formally admitted Fellows of the Society.

A certificate was read for the first time in favour of Mr. Hugh Manners, Academy House, Airdrie, N.B.

Dr. Tate was reinstated as a Fellow of the Society.

The following were duly elected Fellows of the Society: Messrs. Robert Addie, John Caley, Charles Matthew Crossmann, B.Sc., Llewellyn John Davies, Leon Felix Goldstand, LL.D., Ralph Hamilton Hanger, Frederick William Harris, Ernest George Hill, B.A., Joshua Arthur Hughes, John Burnett Knight, Herbert E. Law, William Arthur Finch Lethbridge, B.A., Cecil Rudolf Lidgey, Percy Sykes Marshall, William McConnell, jun., Loxley Meggitt, Asutosh Rai Bahadur Mitra, James Stanley Muir, B.Sc., James Hadden Overton, Hastings Montague Page, Arthur Payne, Sigmund Georgjewitsch Rosenblum, Samuel Thomas Skelton, George Egerton Scott Smith, Douglas Stuart Spens Stuart, B.Sc., James Whitehead.

Of the following papers, those marked * were read.

*75. "The action of bromine on pinene with reference to the question of its constitution." By W. A. Tilden, D.Sc., F.R.S.

Experiments made by the author in 1888 led him to believe that pinene combines not only with two atoms, but with four atoms of bromine. This conclusion was confirmed by the independent experi-

ments of Stschukareff in 1893. Wallach, however, maintains that pinene can unite with only two atoms of bromine, and the various formulæ proposed by different chemists for this hydrocarbon are based on that assumption. The author has, therefore, undertaken a fresh inquiry, as the result of which he is confirmed in his original opinion that pinene combines directly with four atoms of bromine, the amount of bromine entering the molecule by substitution for hydrogen being comparatively insignificant. He therefore proposes for pinene a formula, $\text{C}_3\text{H}_7\cdot\text{CH}\cdot\overset{\text{CH}_2\cdot\text{C}\cdot\text{CHCH}_3}{\underset{\text{C}\cdot\text{CH}_2}{\parallel}}\cdot\text{C}\cdot\text{CH}_2$, derived from a ring of six carbon atoms with a *double* para-linkage, the disruption of which at once gives a cycloid closely related to benzene, and accounts for the ready formation of cymene, &c.

*76. "Preliminary note on some products from pinene tetrabromide."
By W. A. Tilden, D.Sc., F.R.S., and A. Nicholls.

The liquid tetrabromide formed by the addition of pinene to four atoms of bromine, as described in the preceding paper, is a very unstable compound, for it begins to evolve hydrogen bromide soon after its formation if kept at or near the temperature of the air. In order to investigate the products of this decomposition, a considerable quantity of the bromide was prepared. From the resulting colourless solution the carbon tetrachloride was distilled by a water bath, and the residual liquid subjected to distillation alone with the object of expelling as much as possible of the hydrogen bromide, which escaped for the most part as gas. A colourless distillate was obtained, leaving a small quantity of a brown oily residue, which boils at a high temperature with further decomposition. On redistilling the perfectly colourless distillate under pressure reduced to about 10 mm., it came over between 125° and 175°, leaving a small additional quantity of the dark residue, from which, after standing a few hours or days, a crystalline substance was deposited, which was identified by analysis and melting point as Wallach's dibromide, $\text{C}_{10}\text{H}_{16}\text{Br}_2$, m. p. 169—170° (*Annalen*, 264, 7).

In order to decompose the last portions of bromide in the distilled liquid, it was heated with excess of aniline to the boiling point of the latter, and subsequently steam distilled. The distillate, acidified with dilute sulphuric acid in order to fix the small quantity of aniline present, and again steamed, gave a colourless hydrocarbon lighter than water. By fractionation, this was found to yield a portion boiling at 155—157°, which contains solid camphene crystallisable by cooling. The larger part comes over between 158° and 162°, and deposits no solid at -15°. Smaller fractions up to 185° were obtained, and these remain to be examined. The chief fraction,

158—162°, reduced aqueous solution of permanganate at 16—18°, and fixed a quantity of bromine corresponding approximately to Br_2 for C_{10} .

As with the quantity of hydrocarbon at our command it seemed improbable that a fraction could be separated in a pure state, it was thought best to submit the liquid to oxidation. Two portions, the product of one preparation of bromide, were taken, namely, 30 grams, boiling between 155° and 160°, from which the camphene had been frozen out as completely as possible, and 30 grams boiling between 160° and 170°. Oxidation with aqueous permanganate at a temperature which never rose above 26° gave the same chief product, and the two products were therefore supposed to contain a common ingredient. The unchanged hydrocarbon and precipitated oxide of manganese having been removed, the clear solution was mixed with a quantity of sulphuric acid calculated to neutralise the alkali contained in it. A white cloud made its appearance, which was removed on shaking with ether. The ethereal extract, submitted to distillation, left a watery residue, in which floated a nearly colourless oil of about the same density as water. The 30 grams of hydrocarbon at 155—160° gave 7.5 grams of this fluid, and the 30 grams at 160—170° gave 6 grams. This substance is a well-marked acid, having a sour and astringent taste; it decomposes carbonates, and, when mixed with solutions of soda develops much heat. Distilled under a pressure of 20 mm., it partly passed over at 200—210°, but evidently undergoes decomposition. It yields a crystalline, slightly soluble sodium salt. A solution of this salt gives with copper sulphate a greenish precipitate, which seems to be a basic salt, and with silver nitrate a white precipitate, which becomes brownish on exposure to light but does not blacken on boiling. Analyses were made of the acid (left in a vacuum till it ceased to lose weight) and of the crystallised sodium salt, with results corresponding to the formulæ $\text{C}_{10}\text{H}_{16}\text{O}_3$ and $\text{C}_{10}\text{H}_{15}\text{NaO}_3$.

This compound does not appear to be a ketonic acid, and the remarkable properties of its sodium salt lead to the suspicion, notwithstanding that it has not yet been crystallised, that it may be identical with Baeyer's nopic acid, a bye-product recently obtained in the oxidation of crude pinene by permanganate (*Ber.*, 29, 25). This, however, can only be settled by further inquiry, for which materials are already partly prepared.

*77. "An apparatus for showing experiments with ozone." By G. S. Newth.

The special feature of this apparatus consists in the device for introducing reagents into the ozonised oxygen without disturbing the

volume of the gas. The reagent is contained in a sealed capillary tube, which is retained in position by means of four small raised points of glass upon the walls of the inner and outer tubes of the ozone apparatus. The inner tube is ground to fit the outer one, and by a slight turn of the former the tube containing the reagent can be broken. In this way it is possible to show that the contraction in volume due to the absorption of ozone by turpentine is exactly twice as great as that which is produced by ozonising the oxygen, and also that when ozone is acted upon by potassium iodide a volume of oxygen equal to that of the ozone is liberated.

***78. "Note on santalal and some of its derivatives." By Alfred C. Chapman, F.I.C., and Herbert E. Burgess.**

In connection with a study of certain hydrocarbons allied to the sesquiterpenes, upon which one of the authors is engaged, it became a matter of interest to determine more carefully the chemical properties of cedrene, and to compare it with the hydrocarbon obtained by the action of phosphorus pentoxide on santalal, with which it is generally said to be identical.

The cedrene was prepared by the fractional distillation of about 1 litre of cedarwood oil under reduced pressure, and had a corrected boiling point of $261-262^{\circ}$. Its density at $15^{\circ}/15^{\circ}$ was 0.9359, and it produced, in a 100-mm. tube, a laevorotation of 60° . Its refractive index for the red hydrogen line and for the sodium line was $\mu_{H\alpha} = 1.4991$; $\mu_D = 1.5015$.

Although cedrene is unsaturated, and combines readily with hydrogen chloride and bromine, no definite compounds with these substances could be isolated. Negative results were also obtained in the case of the oxides of nitrogen and nitrosyl chloride.

Santalal was next prepared by the fractional distillation of santalwood oil. Its corrected boiling point was found to be $301-306^{\circ}$, some decomposition occurring at this temperature. Its density was $d_{15^{\circ}/15^{\circ}} = 0.9793$; $d_{20^{\circ}/20^{\circ}} = 0.9761$, and its specific rotatory power at 27° was $-14^{\circ} 42'$ for sodium light.

Its refractive index for the lines C and D was $\mu_{H\alpha} = 1.5051$; $\mu_D = 1.5085$. Its specific refractive energy is, therefore, 0.3039, and its molecular refractive energy 66.8. $C_{15}H_{21}O$ requires 66.3. Its general properties are those of an aldehyde.

On oxidation with an aqueous solution of potassium permanganate it yielded an acid crystallising from dilute alcohol in thin, pearly plates melting at 76° . For this substance the name "santalenic acid" is suggested. This acid is still under investigation.

From santalal the hydrocarbon, $C_{15}H_{22}$, was prepared by treatment with phosphorus pentoxide and subsequent fractionation under re-

duced pressure. The main fraction was then obtained as a colourless liquid boiling between $140-145^{\circ}$ (25 mm.). Its density at $15^{\circ}/15^{\circ}$ was 0.9359. In a 100-mm. tube at 16° it produced a rotation of $5^{\circ} 45'$ to the right. This hydrocarbon is unsaturated, combining directly with hydrogen chloride and bromine, but no definite compound could be obtained. Attempts to prepare compounds with the oxides of nitrogen and nitrosyl chloride were equally unsuccessful.

So far as these results go they show that cedrene and the hydrocarbon from santalal are very similar, but not identical.

*79. "Second note on the liberation of chlorine during the heating of a mixture of potassic chlorate and manganic peroxide." By Herbert McLeod, F.R.S.

This paper is a reply to a criticism by O. Brunck (*Zeit. anorg. Chem.*, 1895, 10, 222) on a previous note, in which it was shown that chlorine is produced by heating a mixture of potassic chlorate and manganic peroxide. Brunck considers that the evidence is insufficient, and that the author was misled by the presence of potassic chloride mechanically carried over by the gas. Further experiments have been carried out in a different manner, arising from a suggestion of Dr. Armstrong. The mixture of potassic chlorate and manganic peroxide was heated in a test-tube by the vapour of boiling mercury, and the gas passed into an exhausted flask. After the lapse of some days, during which the suspended matter settled, the gas was pumped out through U-tubes containing solutions of sodic carbonate and potassic iodide. When the gas traversed the sodic carbonate first, no colouration was seen in the potassic iodide, even when this was done immediately after the gas was collected, showing the absence of ozone. On acidifying the sodic carbonate solution with nitric acid, and adding argentic nitrate, a precipitate of chloride was formed which was weighed, and from it the quantity of chlorine was calculated. In three experiments the quantities of chlorine were 0.064, 0.063 and 0.057 per cent. on the quantity of potassic chlorate used. When the gas, after three days' rest, was passed through a solution of potassic iodide and then through sodic carbonate, the latter did not contain chloride, and the former solution was coloured; on determining the liberated iodine volumetrically it was found to correspond to a quantity of chlorine equal to 0.063 per cent. on the chlorate. Sodic hydrate solution that was used for washing oxygen, prepared by heating the usual mixture, was found to contain permanganate, some oxide of manganese having been mechanically carried into the solution, showing that the gas contained chlorine, for ozone does not produce permanganate when in contact with sodic hydrate containing manganic peroxide.

*80. "Polymorphism as an explanation of the thermochemical peculiarities of chloral and bromal hydrates." By William Jackson Pope.

Berthelot has observed that the heat of combustion of chloral hydrate decreases as the time elapsing since fusion and solidification of the sample increases; the same observation has been made by Bruner respecting bromal hydrate. No explanation of this peculiarity is offered by either of these chemists, although Bruner states that other substances such as thymol and menthol, which are pasty after solidification, do not show the same behaviour.

In the case of chloral hydrate at least, the explanation of the gradually decreasing heat of combustion is a purely crystallographic one. On cautiously melting the hydrate on a microscopic slide under a cover slip, and allowing the slide to cool, solidification readily occurs, and a thin crystalline film of the substance suitable for micro-crystallographic examination is obtained; it consists entirely of felted acicular crystals, most of which are so orientated that the optic axial direction of an optically negative uniaxial substance is perpendicular to the surface of the slide; in other crystals the optic axis emerges obliquely, and sometimes the crystals are slightly biaxial. A few of the needles may be truly biaxial, but this can hardly be stated definitely. After several hours at the ordinary temperature, minute rhomboidal plates make their appearance amongst the needles, and, after 24 hours have become sufficiently large for crystallographic examination. The number and size of these plates which belong apparently to the monosymmetric system, increase continuously, whilst the number of needles decreases until, after six or eight days, none but the monosymmetric plates remain. It is thus evident that on solidification of chloral hydrate a uniaxial form is obtained which very slowly changes into a biaxial modification stable at ordinary temperatures; this change must be accompanied by an evolution of heat, as are all changes of the kind, so that freshly solidified chloral hydrate has a larger heat of combustion than a sample solidified several days before burning. The change of any particular spot in the slide may be best observed and recorded photographically, and several good series of micro-photographs have been taken between crossed Nicols at definite intervals of time, which show the transition in a very perfect manner.

On similarly examining bromal hydrate, no very distinct evidence of change is obtained, the solidified mass being scarcely suitable for micro-crystallographic examination. The photographic record, however, seems to indicate a change of some kind in the plate.

The thermochemical behaviour of thymol must, as found by

Bruner, be quite normal, because no crystalline change of any kind occurs in it after solidification has once occurred.

After melting menthol, the other instance quoted by Bruner, it solidifies from centres giving a radially crystallised film. There is usually just time to give a photographic plate an exposure of three minutes on the preparation, however, before a change of crystalline form sets in and the menthol becomes rapidly converted into a mass of very minute crystals which show aggregate polarisation; after this no further change occurs. Since the time elapsing between cooling and the formation of the crystalline modification of menthol stable at ordinary temperatures, is too short to allow of the substance being weighed and introduced into the calorimetric bomb, the heat of combustion determined has always been that of the modification stable at ordinary temperatures.

The crystallographic examination of these substances shows that thermochemical data respecting solid organic substances should always be accompanied by a crystallographic description of the material used.

81. "Explosion and detection of acetylene in air." By Frank Clowes, D.Sc.

The behaviour of mixtures of air with gradually increased proportions of acetylene, when brought into contact with flame, were studied by a method recently described by the author.

The method enables mixtures in varied and accurately known proportion to be rapidly prepared. The proportion of acetylene was progressively increased from 1 to 82 per cent.

The mixture containing 3 per cent. of acetylene was the first which was affected by contact with the flame placed either above or below. A pale green flame slowly traversed the mixture, showing that it was feebly explosive. As the proportion of acetylene was increased, the rapidity of combustion increased, and even a small volume of the mixture gave decidedly explosive effect.

When 22 per cent. of acetylene was present, the explosive combustion of the mixture was attended with a slight separation of unburnt carbon. As the proportion of acetylene was increased the separation of carbon was more marked. The limit of explosibility, as judged by the flame traversing the mixture, was reached when 81 per cent. of acetylene was present.

The range of explosibility of mixtures of air with acetylene, extending from 3 per cent. of acetylene to 81 per cent., is extraordinarily wide, exceeding that of any combustible gas yet experimented with. It seems highly probable that the appearance of combustion extending through the mixture with the higher proportions of

acetylene is partly due to acetylene being an endothermic compound. Accordingly, the combustion of a small portion of the acetylene in contact with the kindling flame, starts the decomposition of the remainder of the acetylene, with the production of heat and the appearance of combustion. This probably explains why air containing much acetylene becomes heated throughout, when it is kindled at one point, and thus extends the range of explosibility of mixtures of acetylene with air.

In estimating the percentage of acetylene in air, if the amount does not reach the lower explosive limit of 3 per cent., the most convenient method was the passage of the air over a standard hydrogen flame, and an examination and measurement of the halo or "flame cap" which was seen in a darkened room over the hydrogen flame. A laboratory apparatus suitable for this purpose is nearly perfected, and will probably be found convenient as a means for measuring accurately the percentage of any combustible gas present in air. About 600 c.c. of the mixture are required for the estimation, which is completed in a few seconds.

When air containing less than 3 per cent. of acetylene was passed over the standard 10-mm. hydrogen flame, the flame at once became yellowish-green in tint. A halo or "cap" was at the same time seen, the height of which increased so rapidly with the increase in the percentage of acetylene, that the last estimation was made by the use of a reduced 5-mm. hydrogen flame. The measurements of the "cap" over the 10-mm. hydrogen flame were as follows:—0.25 per cent., 17-mm. cap; 0.5 per cent., 19 mm.; 1 per cent., 28 mm.; 2 per cent., 48 mm. Over the 5-mm. flame 2.5 per cent. gave 56-mm. cap, and 2.75 per cent. 79-mm. cap. When the percentage reached 3 per cent. it burnt throughout, giving no cap.

82. "On the occurrence of quercetin in the outer skins of the bulb of the onion (*Allium Cepa*). By A. G. Perkin and J. J. Hummel.

Zeuch (*Farben und Farbenkunde*, 1825, 1, 434) has described the dyeing properties of these skins. The colouring matter was obtained by the authors in the form of glistening, yellow needles of the formula $C_{15}H_{10}O_7$, which yielded compounds with mineral acids, the sulphuric acid compound $C_{15}H_{10}O_7 \cdot H_2SO_4$ was analysed. On acetylation, a compound, $C_{15}H_5O_7(C_2H_3O)_5$, forming colourless needles, melting point $190-191^\circ$, was obtained, and by decomposition with fused alkali, phloroglucin and protocatechuic acid formed the principal products. With mordants it dyed shades similar to those given by quercetin the colouring matter of quercitron bark, and was thus proved to be identical with this substance.

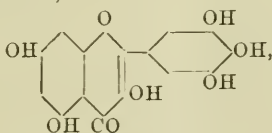
Comparative dyeing experiments showed that the colouring matter

of onion skins was quite equal to that of such well-known dye-stuffs as old fustic and quercitron bark.

83. "On the colouring matter contained in the bark of *Myrica nagi*."

By A. G. Perkin and J. J. Hummel.

Myrica nagi is an evergreen tree, belonging to the Myricaceae occurring in the sub-tropical Himalayas, in the Khasia mountains, the Malay Islands, and Japan. The bark, which is used as a tanning agent, and occasionally for medicinal purposes, was found to contain a yellow colouring matter. This formed yellow needles, closely resembling quercetin, having the formula $C_{15}H_{10}O_8$, and yielding compounds with mineral acids, $C_{15}H_{10}O_8H_2SO_4$, $C_{15}H_{10}O_8HBr$, $C_{15}H_{10}O_8HCl$, and $C_{15}H_{10}O_8 \cdot HI$, orange to orange-red needles, decomposed by water into the free acid and colouring matter. In strong solutions of alkali it dissolves with an orange colour, which, on dilution and exposure to air, becomes first green, then deep blue, and finally red violet. It dyes shades which, in their general character, closely resemble those produced by quercetin and fisetin. The acetyl derivative, $C_{15}H_4O_8(C_2H_5O)_6$, colourless needles, m. p. $203-204^\circ$, and the benzoyl compound, $C_{15}H_4O_8(C_7H_5O)_6$, m. p. $233-236^\circ$, are described. With fused alkali it yields *phloroglucol* and *gallic acid*, and with bromine a compound (orange-brown needles, m. p. $235-240^\circ$), the analytical numbers for which agree with the formula $C_{15}H_6O_8Br_4$. This is probably a tetrabromo-derivative of the colouring matter, but, on account of its somewhat peculiar properties, it will require further examination. The results of this investigation show that this colouring matter, for which the name *myricetin* is proposed, is most probably an hydroxyquercetin,



and experiments with its alkyl ethers will be carried out to confirm this point. Its colour reactions with dilute alkali are probably due to the oxidation of the pyrogallol nucleus it contains. The amount of colouring matter, isolated by the method described, varied from 0.23 to 0.27 per cent., and the amount of tannin it contained, estimated under the direction of Mr. H. H. Procter, Lecturer on Leather Industries, Yorkshire College, was found to be 27.30 per cent.

84. "Preliminary note on a new base derived from camphoroxime."

By Martin O. Forster, Ph.D.

Camphoroxime undergoes no change when treated with boiling methylic iodide in a reflux apparatus, but on heating it with this

agent in sealed tubes at 170—180°, the hydriodide of a new base is produced, along with campholenitrile. The quantity of the salt obtained from 15 grams of camphoroxime and 30 grams of methylic iodide was 9·5 grams.

The *base* is a colourless, limpid oil, having the odour of piperidine; it boils at 206—207°, and is markedly lævorotatory. It is tertiary in character, and analysis points to the formula $C_{12}H_{19}N$ as representing its composition. (Found: C = 81·06; H = 10·66. Calculated for $C_{12}H_{19}N$, C = 81·35; H = 10·73 per cent.).

The *platinichloride*, $(C_{12}H_{19}N)_2PtCl_6$, crystallises from alcohol in magnificent orange needles, and melts, decomposing at 214·5°; the *hydriodide*, $C_{12}H_{19}N \cdot HI$, separates from water in lustrous straw-yellow six-sided plates, and effervesces vigorously when heated at 285°. The *picrate* and *mercurichloride* are well-defined salts, melting at 190° and 126—128° respectively, whilst the *chromate* crystallises in microscopic pale brown square plates, becoming purple on exposure to light. Incidentally, the *hydrobromide*, and the *acetyl*, and *methyl* derivatives of camphoroxime have been obtained.

85. "The rotation of aspartic acid." By B. M. C. Marshall, A.R.C.S.

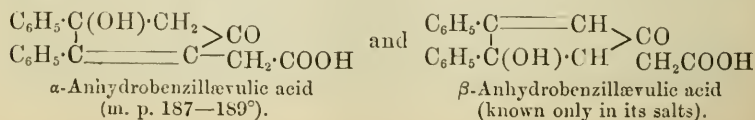
In view of the contradictory statements concerning the rotation of aspartic acid in aqueous solution, the author has re-examined the subject.

Landolt (*Ber.*, 13, 2334) and Becker (*Ber.*, 14, 1035) obtained a *lævo*-rotation for aspartic acid, prepared from ordinary asparagine. Piutti (*Ber.*, 19, 1691), on the other hand, states that ordinary asparagine yields *dextro*-aspartic acid, which is convertible into ordinary *lævo*-malic acid, while the *dextro*-asparagine yields *lævo*-aspartic acid, which gives *dextro*-malic acid.

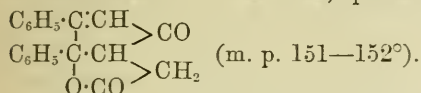
The results obtained by the author confirm the observations of Piutti. The solubility of the aspartic acid in water was found to be in agreement with the results of Pasteur, Guareschi (*Jahresber.*, 1876, 777), and Engel (*Compt. rend.*, 106, 1736), and to be much less than that deduced from Becker's data.

86. "Synthesis of pentacarbon rings. Part III. Condensation of benzil with lævulic acid." By Francis R. Japp, F.R.S., and T. S. Murray, D.Sc.

When benzil and lævulic acid are heated with a solution of caustic potash in dilute alcohol, they condense to form two isomeric compounds.



These two *diphenylhydroxycyclopentenonylacetic acids* are allied to anhydracetonebenzil, which is a *diphenylhydroxycyclopentenone* (Japp and Lander, Proc., 1896, 107). The α -acid is stable; the β -acid, when liberated from its salts, spontaneously changes into the lactone,



Both the α -acid and the lactone of the β -acid, when boiled for from one to two minutes with fuming hydriodic acid, are converted into *diphenylcyclopentenonylacetic acid*, $\begin{array}{c} \text{C}_6\text{H}_5 \cdot \text{C} : \text{CH}_2 \\ \text{C}_6\text{H}_5 \cdot \text{C} \cdot \text{CH} \end{array} \begin{array}{l} > \text{CO} \\ - \text{CH}_2 \cdot \text{COH} \end{array}$ (m. p. 126—127°), a change in the position of the double bonds occurring during the process. The latter acid, on oxidation with sodium hypobromite, yields a mixture of *diphenylmaleic* and *diphenylfumaric acids*.

Oximes and other derivatives of the foregoing compounds have also been prepared.

87. "Absorption of dilute acids by silk." By James Walker and James R. Appleyard.

When silk is dyed with picric acid a real equilibrium is attained which is independent of the original distribution of the materials. If the equilibrium concentration of the picric acid in the silk be denoted by s , and in the water by w , the relation $s/\sqrt{w} = \text{const.}$ exists between these magnitudes. This formula would indicate, according to the solid solution theory of dyeing, that the weight of the molecule of picric acid dissolved in the water would be n times that of the molecule of picric acid "dissolved" in the silk; but this we know to be incorrect, as n is greater than unity, and the molecular weight of picric acid in water is the smallest consistent with its formula.

When other solvents than water are used the rate and amount of dyeing with picric acid seem to be connected with the dissociative power of the solvent. Silk will not take up picric acid from benzene or from carbon tetrachloride, but does so readily from alcohol, less readily from ether and acetone. The ratio of the final concentrations of aqueous and alcoholic solutions of picric acid required to dye silk to a given standard was found to be approximately the ratio of the solubilities of picric acid in water and in alcohol.

A comparison of the extents to which the various acids are absorbed by silk shows that the acids fall into two classes,—the aromatic acids where the absorption is great, and the non-aromatic acids where the absorption is relatively small. In each class there

is a rough parallelism between the strength of the acids and the amount absorbed. The addition of calcium benzoate to a solution of benzoic acid greatly diminishes the strength of the acid, and the absorption also is thereby much diminished.

If dyeing were a pure chemical addition of the dye to the fibre, the theory of mass-action predicts that the equilibrium concentration of the dye-bath should be constant at any given temperature independently of the quantities of material taken. This is not known to be the case for actual dyeing, but it was experimentally verified by "dyeing" diphenylamine brown with picric acid from aqueous solution.

88. "Position-isomerism and optical activity; the methylic and ethylic salts of ortho-, meta-, and para-ditoluyltartaric acid." By Percy Frankland, Ph.D., F.R.S., and Frederick Malcolm Wharton, A.I.C.

The authors have commenced the systematic study of the connection between position-isomerism and rotatory power in optically active substances containing the benzene-ring. The present paper contains an account of the preparation and properties of the methylic and ethylic salts of the three isomeric ditoluyltartaric acids. These substances were obtained by the action of the three toluyl chlorides on methylic and ethylic tartrates respectively. With the exception of the ethylic salts of the diortho- and dimeta-toluyltartaric acids, they were all obtained as beautifully crystalline bodies, the two ethylic salts in question only as viscid liquids. All six compounds are powerfully laevorotatory, the methylic salts more so than the corresponding ethylic ones, and the para-compounds have the highest, the ortho- the lowest, and the meta- an intermediate rotation. As regards other physical properties, in the case of the methyl compounds, all of which are solids at the ordinary temperature, the para- also has the highest, the ortho- the lowest, and the meta-compound an intermediate melting point, whilst the density is distinctly greatest in the case of the ortho-compounds, the meta- and para-compounds having almost exactly equal densities. In all cases the rotatory power was determined in the liquid state, no use being made of solutions, and the rotations were compared over wide ranges of temperature. With rise in temperature the laevorotatory power is in all cases diminished, and since the laevorotation is conditioned by the presence of the aromatic groups (methylic and ethylic tartrates being dextrorotatory) the dominant influence of these groups is reduced with increasing temperature; a perfectly analogous phenomenon has already been shown by one of the authors to take place in the case of the dibenzoylglycerates (Trans., 1896,

106). Moreover, as the laevorotation is conditioned by the toluyll groups, it follows from a comparison of the rotations of the compounds described that the meta-toluyll group has a higher rotatory value than the ortho-, and the para- an even higher one than the meta-.

89. "Double sulphides of gold and other metals, or the action at a red heat of sulphur upon gold when alloyed with other metals." By J. S. Maclaurin, B.Sc., University College, Auckland, New Zealand.

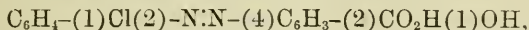
It is shown that when alloyed with silver, lead, copper, or iron, gold is readily converted into a sulphide by the action of sulphur vapour on the melted alloys. Analyses of the compounds so prepared are given which prove that the gold sulphide has the formula, Au_2S .

90. "The relative weights of gold and silver dissolved by potassium cyanide solutions from alloys of these metals." By J. S. Maclaurin, B.Sc.

The author finds that gold and silver are dissolved by solution of potassium cyanide from an alloy of these metals in the proportions by weight in which they exist in it. He shows that this is the ratio of their atomic volumes, and deduces it from the results previously obtained by him (Trans., 1895, 199).

91. "The three chlorobenzeneazosalicylic acids." By J. T. Hewitt, Ph.D., and H. E. Stevenson.

Orthochlorobenzeneazosalicylic acid,



prepared by the addition of diazotised orthochloraniline hydrochloride to an alkaline solution of salicylic acid forms yellow or buff aggregates of small crystals (m. p. 194°).

Besides metallic salts, the methyl and ethyl esters are described. *Methyl orthochlorobenzeneazosalicylate*, m. p. 109° . *Ethyl orthochlorobenzeneazosalicylate*, m. p. $90-96^\circ$.

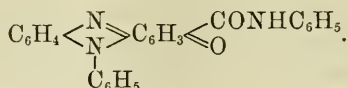
Attempts to remove hydrochloric acid by inorganic bases were fruitless, and diphenyleneazo-derivatives were not produced.

Boiled with aniline, in a flask provided with a reflux tube, a sublimate of ammonium chloride was observed, the chief product of the reaction being a substance of the formula $\text{C}_{23}\text{H}_{17}\text{N}_3\text{O}_2$. To effect its isolation, the contents of the flask are freed from aniline by steam distillation, subsequent treatment with soda removes an acid probably having the formula $\text{C}_{19}\text{H}_{13}\text{N}_2\text{O}_3$; after washing with hydrochloric

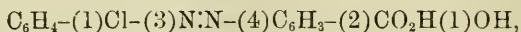
acid, the residue is dissolved in chloroform and precipitated by ligroin as a violet crystalline powder.

The formation of the substance $C_{25}H_{17}N_3O_2$ may be thus represented: $C_{13}H_9ClN_2O_3 + 2C_6H_5NH_2 = C_{25}H_{17}N_3O_2 + NH_4Cl + H_2O$.

The substance possesses neutral properties, and is probably the anilide of a benzeneindulonecarboxylic acid,



Metachlorobenzeneazosalicylic acid,

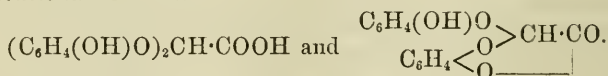


has been previously described (*Ber.*, 1894, **28**, 803). An account is now given of some of its metallic salts. *Methyl metachlorobenzeneazosalicylate* forms yellow needles which melt at 114° . *Ethyl metachlorobenzeneazosalicylate*, m. p. $102-103^\circ$. *Parachlorobenzeneazosalicylic acid*, $C_6H_4-(1)Cl-(4)N:N-(4)C_6H_3-(2)CO_2H(1)OH$, was prepared in the usual manner; it melts at 237° . The *potassium*, *ammonium*, *silver*, and *barium* salts are described. *Methyl parachlorobenzeneazosalicylate*, m. p. 152° . *Ethyl parachlorobenzeneazosalicylate*, m. p. 113° .

For purposes of comparison the methyl and ethyl esters of benzeneazosalicylic acid (Stebbins, *Ber.*, 1880, **13**, 716) have also been prepared. *Methyl benzeneazosalicylate*, m. p. 106° . *Ethyl benzeneazosalicylate*, m. p. $88-89^\circ$.

92. "Condensation of chloral with resorcinol." By J. T. Hewitt, M.A., D.Sc., Ph.D., and F. G. Pope.

H. Causse studied the condensation of chloral with resorcinol in dilute aqueous solution under the influence of sodium hydrogen sulphate (*Bull. Soc. Chim.*, [3], **3**, 861-867). In this manner he obtained a colourless compound of the formula $C_{14}H_{12}O_6$; whilst working with hot solutions, yellow crystals of the formula $C_{14}H_{10}O_5$ were obtained. He assigned to these two substances the following constitutional formulæ

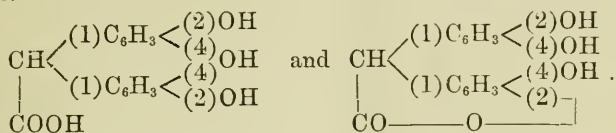


The authors of the present communication have studied the latter substance, and find that it furnishes a triacetyl derivative (m. p. 152°) crystallising in glittering leaflets. The substance $C_{14}H_{10}O_5$ dissolves in cold alkalis with an intense purple colour which disappears on warming, salts of the type $M \cdot C_{14}H_{11}O_6$ being produced. The purple

alkaline solution of the formula $C_{14}H_{10}O_5$ gives a precipitate on acidification, solutions of salts $M \cdot C_{14}H_{11}O_6$ only on boiling for some time.

The conclusion can be drawn that the compound $C_{14}HO_5$ is the lactone of an acid, $C_{14}H_{12}O_6$, which is itself readily soluble in water. This acid must contain four hydroxyl groups, and is, therefore, *tetrahydroxydiphenylacetic acid*.

Probably the acid and lactone possess the following constitutional formulæ.



The authors reserve their views as to the cause of the coloration produced when the lactone is dissolved in cold alkalis.

93. "The atomic weight of Japanese tellurium." By Masumi Chikashigé, B.Sc., Imperial University, Japan.

A redetermination of the atomic weight of tellurium has been made by means of its tetrabromide, and by closely following Brauner in all the details. The result has been to get in the three experiments made, the numbers 127.57, 127.61, and 127.58, which, therefore, agree with his in making the atomic weight 127.6. This work was undertaken by the advice of Dr. Divers, in order to ascertain whether tellurium found under mineralogical conditions quite unlike those pertaining to the tellurium employed by Brauner, Staudenmaier, and all others who have investigated the subject, has the same atomic weight as the latter. That, as is well known, occurs in Hungary and elsewhere, in union with bismuth, gold, silver, &c., while the tellurium employed in this research was obtained from the *red* native sulphur, or telluro-sulphur, of Japan, discovered and described in 1883 by Divers, Shimosé, and Shimidzu. It is extremely improbable that, if the substance known as tellurium is compound, as it has been considered to be by Branner, its composition should be identical when occurring in association with sulphur as a sulphur-like body in Japan, as when occurring in metallic combination in Europe or America. Since Staudenmaier has got the same atomic weight for tellurium of European origin as that found by Brauner, but by a totally different method, and that the author has again got the same atomic weight by Brauner's process, but working on a tellurium of quite dissimilar origin, the point may be regarded as settled that its atomic weight exceeds that of iodine. Its occurrence with sulphur and selenium in the Japanese

mineral at the same time furnishes additional proof that it belongs to the sulphur group.

ADDENDUM, by EDWARD DIVERS.—The case of tellurium and iodine, with atomic weights in the reverse order of their places in the periodic series, is not the only one. Cobalt belongs, undoubtedly, to the second division of Group VIII, and nickel to the third division, according to both Mendeléeff and Lothar Meyer; yet all the elaborate work done on the subject has left cobalt with an atomic weight slightly higher than, or at least equal to, that of nickel. Hence we find in most books cobalt and nickel misplaced in the reproduction of Mendeléeff or Meyer's table. It is to be hoped no one will venture now to misplace tellurium and iodine.

94. "Derivatives of camphene sulphonic acids." By Arthur Lapworth and Frederic Stanley Kipping.

The two chlorocamphenesulphonic chlorides obtained as by-products in the sulphonation of camphor (compare Proc., 1895, 57) have been submitted to a further examination. Although no experimental proof of their relationship to camphene has yet been obtained, their characterisation has now been completed, and a number of new derivatives have been prepared from them.

α-Chlorocamphene sulphochloride, $C_{10}H_{14}Cl \cdot SO_2Cl$, is dimorphous, as was at first suspected (*loc. cit.*). It crystallises from light petroleum or cold methylic alcohol in massive transparent anorthic prisms or plates, which melt at $83-84^\circ$; from hot methylic alcohol it is deposited in small orthorhombic tables which melt at $87-88^\circ$. The latter modification is also obtained when the melted substance is quickly cooled, and undergoes gradual reversion to the anorthic modification at the ordinary temperature. Both forms have been goniometrically measured.

α-Chlorocamphene sulphanilide, $C_{10}H_{14}Cl \cdot SO_2 \cdot NHC_6H_5$, crystallises in small flattened needles, which probably belong to the anorthic system; it is readily soluble in alcohol, but only sparingly soluble in ether or chloroform; it melts and decomposes about $232-234^\circ$.

α-Chlorocamphene sulphonic acid, $C_{10}H_{14}Cl \cdot SO_3H$, crystallises from ether in beautiful glistening elongated plates; it dissolves sparingly in ether and in chloroform, but is insoluble in petroleum. When heated it gradually darkens, and at $264-265^\circ$ swells up and evolves gases, finally forming a dark-coloured, liquid mass.

β-Chlorocamphene sulphochloride, $C_{10}H_{14}Cl \cdot SO_2Cl$, crystallises from anhydrous methylic alcohol in long needles which belong to the tetragonal system, and melts at $83-84^\circ$; the low melting point

(78°) originally observed was probably due to some slight admixture with the isomeric sulphochloride, the latter being almost impossible to eliminate by crystallisation from petroleum.

β-Chlorocamphene sulphanilide, $C_{10}H_{14}Cl \cdot SO_2 \cdot NHC_6H_5$, is slightly soluble in hot water, and crystallises from dilute alcohol in branched aggregates of plates; it melts at 101—103°.

β-Chlorocamphene sulphonic acid, $C_{10}H_{14}Cl \cdot SO_3H$, is readily soluble in water, and crystallises from ether in minute ill-defined leaflets; it melts at 73—74°, and decomposes and evolves gases at about 142°. When the solution of this acid is evaporated to dryness on the water bath, and the residue extracted with water, a substance remains undissolved which is isomeric with *β*-chlorocamphene sulphonic acid. This compound crystallises from methylic alcohol in well-defined plates, which aggregate on pressure to a camphor-like mass; it melts at 183·5—184·5°. It is not altered by hot aniline, but is gradually dissolved by boiling baryta water, forming an ill-defined salt. Its behaviour is in accordance with the supposition that it is the lactone of a hydroxy-sulphonic acid.

95. "Iodoso- and iodoxy-benzaldehydes." By Victor Meyer and T. S. Patterson.

It is shown that *m*- and *p*-iodoso- and iodoxy-benzaldehydes are much easier to prepare than *o*-iodoso-benzaldehyde, which is contrary to the hitherto observed rule.

The preparation of the following new substances is described.

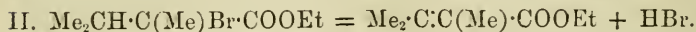
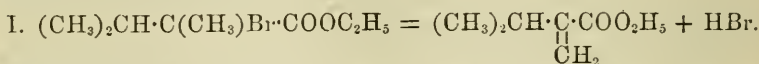
m-Iodo-benzaldehyde, m. p. 57°. *m*-Iodo-benzaldehyde-bichloride. *m*-Iodoso-benzaldehyde; decomposes (*circa*) 190°. *m*-Iodoso-benzaldehyde-acetate, m. p. 157°. *m*-Iodoxy-benzaldehyde. *p*-Iodo-benzaldehyde-bichloride. *p*-Iodoso-benzaldehyde; decomposes at 115°. *p*-Iodoxy-benzaldehyde; decomposes at 216°. *o*-Iodo-benzaldehyde-bichloride. *o*-Iodoso-benzaldehyde; decomposes at 205—210°. *o*-Iodobenzaldoxime, m. p. 107—108°. *m*-Iodo-benzaldoxime, m. p. 62—63°. *p*-Iodo-benzaldoxime, m. p. 111°. *o*-Iodo-benzaldehyde-phenylhydrazone, m. p. 79°. *m*-Iodo-benzaldehyde-phenylhydrazone, m. p. 155°. *p*-Iodo-benzaldehyde-phenylhydrazone, m. p. 121°.

96. "α-Isopropylglutaric acid." By W. H. Perkin, jun., F.R.S.

During the course of experiments on derivatives of glutaric acid, the author had occasion to carefully study the action of alkalis on ethylic methylisopropyl-α-bromacetate, and also the action of this ethereal salt on the sodium derivative of ethylic malonate.

$(CH_3)_2 \cdot CH \cdot C(CH_3)Br \cdot COOC_2H_5$, *ethylic methylisopropyl-α-bromacetate*, was prepared by brominating methylisopropylacetic acid in the

presence of phosphorus, and pouring the product into alcohol; it boils constantly at 130° (100 mm.). When heated with quinoline, this ethereal salt yields a mixture of the ethereal salts of α -isopropylacrylic and of trimethylacrylic acids, elimination of hydrogen bromide taking place in two directions, thus :



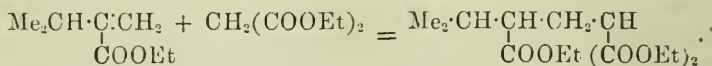
And, when digested with alcoholic potash, the bromethereal salt yields a mixture of the above acrylic acids, together with small quantities of methylisopropyl- α -hydroxyacetic acid.

Trimethylacrylic acid, $(\text{CH}_3)_2\text{C}\cdot\underset{\text{CH}_2}{\underset{\text{||}}{\text{C}}}(\text{CH}_3)\cdot\text{COOH}$, crystallises in colourless prisms, and melts at 71°; it combines with bromine, yielding $\alpha\beta$ -dibromotrimethylpropionic acid, $(\text{CH}_3)_2\text{CBr}\cdot\text{CBr}(\text{CH}_3)\cdot\text{COOH}$ (m. p. 190°), and with hydrogen bromide and hydrogen iodide with formation of $(\text{CH}_3)_2\text{CBr}\cdot\text{CH}(\text{CH}_3)\cdot\text{COOH}$, β -bromotrimethylpropionic acid (m. p. 79°), and $(\text{CH}_3)_2\text{CI}\cdot\text{CH}(\text{CH}_3)\cdot\text{COOH}$, β iodotrimethylpropionic acid, (m. p. 81°) respectively.

α -Isopropylacrylic acid, $(\text{CH}_3)_2\text{CH}\cdot\underset{\text{CH}_2}{\underset{\text{||}}{\text{C}}}\cdot\text{COOH}$, has not been obtained in a pure state.

$(\text{CH}_3)_2\text{CH}\cdot\text{C}(\text{OH})\cdot\text{CH}_2\cdot\text{COOH}$, methylisopropyl- α -hydroxyacetic acid, crystallises in colourless prisms and melts at 75–76°.

Condensation of Ethylic Isopropylacrylate with the Sodium Compound of Ethylic Malonate.—When the mixed ethereal salts of isopropyl glutaric acid and trimethylglutaric acid (as obtained by the action of quinoline on ethylic methylisopropyl- α -bromacetate) are digested with the sodium derivative of ethylic malonate in alcoholic solution, condensation takes place, curiously enough, only in the case of the former substance.



The ethylic isopropylpropanetricarboxylate thus formed is a thick colourless oil which boils constantly at 209° (45 mm.), and, on hydrolysis, yields the corresponding isopropylpropanetricarboxylic acid; this acid melts at 165° with decomposition into CO_2 and α -isopropylglutaric acid.

α -Isopropylglutaric acid, $(\text{CH}_3)_2\text{CH}\cdot\underset{\text{COOH}}{\underset{\text{||}}{\text{C}}}\cdot\text{CH}_2\cdot\underset{\text{COOH}}{\underset{\text{||}}{\text{C}}}\cdot\text{CH}_2$, melts at 94–

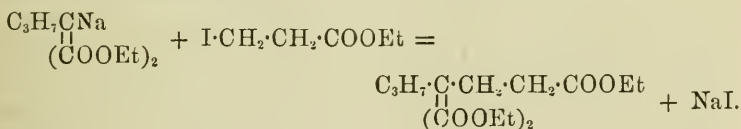
95°, and in its properties shows considerable resemblance to the isomeric $\text{COOH}\cdot\text{CH}_2\cdot\text{C}(\text{CH}_3)_2\cdot\text{CH}(\text{CH}_3)\cdot\text{COOH}$, $\alpha\beta\beta$ -trimethylglutaric acid, which Balbiano (*Der.*, 1895, 28, 1507) obtained from the pro-

ducts of the oxidation of camphoric acid with cold potassium permanganate. It yields an ethereal salt which boils at 158—160° (45 mm.), an anhydride, $C_8H_{12}O_3$ (m. p. 53°), an anilic acid, $C_{14}H_9NO_3$, which melts at 159°, and it is oxidised by chromic acid with formation of acetic and succinic acids.

Action of Ethylic Methylisopropyl- α -Bromacetate on the Sodium Compound of Ethylic Malonate.—This reaction was studied under a variety of conditions, using alcohol and xylene as solvents, but in all cases the product was found to be identical with the ethylic isopropylpropanetricarboxylate, obtained, as described above, by the condensation of ethylic isopropylacrylate with the sodium derivative of ethylic malonate. During this reaction the ethylic methylisopropylbromacetate is obviously first converted into ethylic isopropylacrylate, which then condenses with the sodium compound of the ethylic malonate in the manner described above.

97. "The action of ethylic β -iodopropionate on the sodium derivative of ethylic isopropylmalonate." By J. Z. Heinke and W. H. Perkin, jun., F.R.S.

These experiments were instituted with the object of obtaining additional evidence as to the constitution of the isopropylglutaric acid described in the preceding abstract. When ethylic β -iodopropionate is digested in alcoholic solution with the sodium derivative of ethylic isopropylmalonate, the reaction proceeds as follows.



and the product formed was found to be identical with the ethylic isopropylpropanetricarboxylate described in the preceding abstract. The ethereal salt on hydrolysis yielded isopropylpropanetricarboxylic acid (m. p. 165°), and this at 180° yielded isopropylglutaric acid (m. p. 94—95°). A number of derivatives of this acid were prepared, and in this way its identity with the isopropylglutaric acid, described in the preceding abstract, was conclusively proved.

98. "The condensation of halogen derivatives of fatty ethereal salts with ketones, and ketonic acids." By W. H. Perkin, jun., F.R.S., and J. F. Thorpe.

The condensation of substance containing the group $>CO$ with halogen derivatives in the presence of zinc appears to have been first studied by Frankland and Duppa (*Annalen*, **133**, 80); these chemists

synthesised ethylic hydroxyisobutyrate, $(\text{CH}_3)_2\text{C}(\text{OH})\cdot\text{COOC}_2\text{H}_5$, by acting on a mixture of methylic iodide and ethylic oxalate with zinc.

Since then work has been done on this condensation by several chemists, and quite lately by Reformatzky (*Ber.*, 1895, **28**, 2838), and we have lately employed it with success in preparing the following interesting substances, of which we give a brief account, in order to reserve them for further investigation in the autumn.

(1) $\text{COOC}_2\text{H}_5\cdot\text{CH}_2\cdot\text{C}(\text{OH})(\text{CH}_3)\cdot\text{C}(\text{CH}_3)_2\cdot\text{COOC}_2\text{H}_5$, *ethylic β -hydroxy- $\alpha\alpha\beta$ -trimethylglutarate*, is produced by the action of zinc on a mixture of ethylacetoacetate and *ethylic α -bromoisobutyrate*, or of *ethylic bromoacetate* and *ethylic dimethylacetoacetate*. It is a thick, colourless oil, which boils at 165° (35 mm.), and which, on hydrolysis, is decomposed, with formation of acetic and isobutyric acids. When treated with a mixture of tribromide and pentabromide of phosphorous, it is converted into $\text{COOC}_2\text{H}_5\cdot\text{CH}_2\cdot\text{CBr}(\text{CH}_3)\cdot\text{C}(\text{CH}_3)_2\cdot\text{COOC}_2\text{H}_5$, *ethylic β -bromo- $\alpha\alpha\beta$ -trimethylglutarate*, which distils with slight decomposition at 170 – 175° (30 mm.), and, when digested with potassium cyanide in alcoholic solution, is reduced, with formation of $\text{COOC}_2\text{H}_5\cdot\text{CH}_2\cdot\text{CH}(\text{CH}_3)\cdot\text{C}(\text{CH}_3)_2\cdot\text{COOC}_2\text{H}_5$, *ethylic $\alpha\alpha\beta$ -trimethylglutarate*. This ethereal salt boils at 162° (40 mm.), and, on hydrolysis, yields *$\alpha\alpha\beta$ -trimethylglutaric acid*, a colourless crystalline substance, which melts at 147° .

(2) The ethereal salt of the lactone of *$\alpha\alpha\beta$ -trimethyl- β -hydroxyadipic acid*, $\text{COOC}_2\text{H}_5\cdot\text{C}(\text{CH}_3)_2\cdot\underset{\text{O}}{\underset{|}{\text{C}}}(\text{CH}_3)\cdot\text{CH}_2\cdot\underset{\text{O}}{\underset{|}{\text{C}}}\text{CH}_2$, is produced by distilling the product of the condensation of ethylic levulinate and ethylic bromoisobutyrate. It boils at 187 – 188° (30 mm.), and dissolves in ammonia and aqueous potash, being precipitated on the addition of acids unchanged. When hydrolysed with aqueous potash at 0° , it yields the corresponding acid, a colourless crystalline substance, which melts at 105 – 106° .

(3) Ethylic pyruvate and ethylic β -bromoisovalerate condense readily in the presence of zinc, with formation of *ethylic α -hydroxy $\alpha\beta\beta$ -trimethylglutarate*, $\text{COOEt}\cdot\text{C}(\text{OH})(\text{Me})\cdot\text{CMe}_2\cdot\text{CH}_2\cdot\text{COOEt}$, a colourless oil, which boils at 160 – 170° (60 mm.).

(4) *Ethyl α -methyl- β -hydroxyvalerate*, $\text{Me}_2\text{C}(\text{OH})\cdot\text{CH}(\text{Me})\cdot\text{COOEt}$, is produced by the condensation of ethylic bromopropionate with acetone. It is a colourless oil, which distils at 105° (30 mm.), and on hydrolysis yields the corresponding *α -methyl- β -hydroxyvaleric acid*, a thick colourless syrup, boiling at 160° (35 mm.). From this acid the following derivatives have been prepared.

α -Methyl- β -bromoisovaleric acid, $(\text{CH}_3)_2\cdot\text{CBr}\cdot\text{CH}(\text{CH}_3)\cdot\text{COOH}$, a white, crystalline solid, melting at 79° , and yielding an oily ethereal salt, which distils in a vacuum almost without decomposition.

α-Methyl-β-iodoisovaleric acid, $(\text{CH}_3)_2\text{CI}\cdot\text{CH}(\text{CH}_3)\cdot\text{COOH}$, melts at 81° .

Trimethylacrylic acid, $(\text{CH}_3)_2\text{C}:\text{C}(\text{CH}_3)\cdot\text{COOH}$, is formed by the hydrolysis of *ethyl α-methyl-β-bromisovalerate* with alcoholic potash. It crystallises from water in colourless prisms, which melt at $70\text{--}71^\circ$, and distils without decomposition at $145\text{--}150^\circ$ (50 mm.). It combines with bromine readily, yielding dibromotrimethylpropionic acid, $(\text{CH}_3)_2\text{CBr}\cdot\text{CHBr}\cdot\text{COOH}$, melting at 190° .

99. "The electrolysis of the salts of monhydroxy acids." By J. Wallace Walker, M.A., Ph.D.

An unsuccessful attempt was made to synthesise the alcohols of the glycollic series by electrolysis of strong solutions of the salts of the monhydroxy-acids.

100. "The action of formic aldehyde on phenylhydrazine, and on some hydrazones." By J. Wallace Walker, M.A., Ph.D.

Besides the already known compound, $(\text{C}_6\text{H}_5\text{N}_2)_2(\text{CH}_2)_3$, obtained by the interaction of these substances, the author has prepared a number of others by varying the conditions of the reaction. The relationships of the different substances is fully discussed in the paper.

101. "The colouring matter of Sicilian sumach, *Rhus coriariæ*." By A. G. Perkin and George Young Allen.

Sumach, which consists of the dried and powdered leaves of the genus *Rhus*, especially *R. coriaria* (Sicilian), and *R. cotinus* (Venetian sumach), is used in tanning, and also in dyeing and calico printing, on account of the tannin matter it contains, which according to Löwe is gallotannic acid (Fresenius, *Zeit. anal. Chem.*, **12**, 128). According also to Chevreul, it contains a yellow colouring matter (*Watts Dict. Chem.*, 1874, **5**, 614). Löwe (*Zeit. anal. Chem.*, **12**, 127), who examined the different varieties of sumach, stated that they contain quercetin and quercitrin, but this is certainly incorrect as regards Sicilian sumach.

The colouring matter, $\text{C}_{15}\text{H}_{10}\text{O}_8$, forms glistening yellow needles, having dyeing properties similar to those of quercetin and fisetin, but is distinguished from these by its colour reactions with dilute alkalis. The sulphuric acid compound, $\text{C}_{15}\text{H}_{10}\text{O}_8\cdot\text{H}_2\text{SO}_4$, forms orange red needles, and the acetyl derivative, $\text{C}_{15}\text{H}_4\text{O}_8(\text{C}_2\text{H}_3\text{O})_6$, colourless needles, m. p. $203\text{--}204^\circ$. Fused with alkali, it yields *phloroglucol* and *gallic acid*. These reactions show it to be identical with *myricetin*, the colouring matter of *Myrica nagi* (see previous abstract). Sicilian sumach also contains some quantity of free gallic acid.

102. "The colouring matter of Querbracho Colorado." By Arthur G. Perkin and Oswald Gunnell.

The wood of *Querbracho colorado* constitutes the tannin matter "querbracho," which is suitable for the production of Morocco leather, and, moreover, in conjunction with alum, it gives the leather a bright yellow shade, instead of the darker colours prepared in the ordinary way. Jean (*Bull. Soc. Chim.*, **33**, 6) found it to contain a tannin differing from those of oak bark and chestnut wood. According to Arnandon (*Watts Dict. Chem.*, **8**, 1732), it contains a yellow colouring matter.

The colouring matter, $C_{15}H_{10}O_6$, forms glistening yellow needles, dyeing shades similar to those of quercetin, and yielding compounds with mineral acids. The benzoyl derivative, $C_{15}H_6O_6(C_7H_5O)_4$, colourless needles, m. p. $180-181^\circ$, and the acetyl derivative, $C_{15}H_6O_6(C_2H_3O)_4$, colourless needles, m. p. $196-198^\circ$, were prepared. Fused with alkali, it yields *protocatechuic acid*, and probably *resorcinol*. Its dyeing properties were identical with those of fisetin, $C_{15}H_{10}O_6$, the colouring matter of young fustic (*Rhus cotinus*), and there could be little doubt that it was *fisetin*.

A second substance, $C_{14}H_{10}O_{10}$, forming minute prisms, was also isolated, and was found to be *ellagic acid*, and further, the presence of a considerable quantity of *gallic acid* was detected, these latter being, no doubt, chiefly formed during the isolation of the fisetin from the querbracho.

103. "On atisine, the alkaloid of *Aconitum heterophyllum*." By H. A. D. Jowett, D.Sc.

The author has investigated the nature and properties of the alkaloid contained in the roots of the non-toxic *Aconitum heterophyllum*. This alkaloid was examined by Broughton in 1873, who named it atisine, and ascribed to it the formula $C_{46}H_{74}N_2O_5$; it was subsequently examined by Wasowicz and by Alder Wright. The powdered roots were extracted by percolation with a mixture of methyl and amyl alcohol, and from this percolate was obtained the crystalline hydrochloride or hydriodide by the method described in the paper.

Atisine, for which the author adopts the formula $C_{22}H_{31}NO_2$, could only be obtained as a colourless varnish, soluble in alcohol, ether, or chloroform, slightly soluble in water, and insoluble in petroleum ether. Its alcoholic solution is laevorotatory, $[\alpha]_D = -19.6^\circ$, and though the base is amorphous it yields a series of crystalline salts.

Atisine hydrochloride, $C_{22}H_{31}NO_2 \cdot HCl$, crystallises either from water or from a mixture of alcohol and ether in well-defined prisms, which melt at 296° (corr.), and are freely soluble in water or alcohol, but

insoluble in ether. The aqueous solution of the salt is dextrorotatory, $[\alpha]_D = +18.46^\circ$.

Atisine hydrobromide, $C_{22}H_{31}NO_2 \cdot HBr$, crystallises from water or a mixture of alcohol and ether, either singly or in rosettes of needles, which melt at 273° (corr.). The salt is freely soluble in water and alcohol, but insoluble in ether or petroleum ether, and in aqueous solution is dextrorotatory, $[\alpha]_D = +24.3^\circ$.

Atisine hydriodide, $C_{22}H_{31}NO_2 \cdot HI$, crystallises from hot water or alcohol in well-defined plates or tables, melting at $279-280^\circ$ (corr.), soluble in hot water or alcohol, but sparingly soluble in cold water. Its aqueous solution is dextrorotatory, $[\alpha]_D = +27.4^\circ$. This salt cannot apparently be prepared by the direct action of hydrogen iodide upon the base, but is easily prepared by precipitating a solution of any salt of atisine with potassio-mercuric iodide, and decomposing the precipitate with hydrogen sulphide.

The *nitrate* (m. p. 252° , corr.) and *platinichloride* (m. p. 229° , corr.) were also obtained as well-defined, crystalline salts, but the *aurichloride* could only be obtained as an amorphous powder. The results of the analyses of a number of pure salts led to the adoption of the formula $C_{22}H_{31}NO_2$ for the base.

The hydriodide, when treated with hydrogen iodide, yielded no methyl iodide, and thus the alkaloid was shown to contain no methoxyl groups.

When either the base or its salts are mixed with alkalis or acids in either alcoholic or aqueous solution, no fission of the molecule takes place, but a new base, atisine monohydrate, $C_{22}H_{31}NO_2 \cdot H_2O$, is formed. Neither this base nor any of its salts could be obtained in the crystalline condition, but analyses of the *aurichloride* and *platinichloride* confirmed the formula given above.

A preliminary examination of the physiological action of the nitrate by Dr. Cash, F.R.S., showed that the alkaloid is non-toxic, and that its action somewhat resembles aconine.

104. "The action of methyl alcohol on aconitine. Formation of methyl benzaconine." By Wyndham R. Dunstan, F.R.S., Thomas Tickle, and D. H. Jackson, Ph.D.

When aconitine (or a salt) is heated with methyl alcohol in a closed tube between $120-130^\circ$, the alkaloid loses one molecular proportion of acetic acid and takes up one methyl group, forming *methyl benzaconine*, $C_{33}H_{45}NO_{12} + CH_3OH = C_{33}H_{45}NO_{11} + CH_3COOH$. The composition of the new base has been ascertained by combustion and verified by estimation of the quantity of acetic acid separated in its production from aconitine, by estimation of the amount of benzoic acid separated on hydrolysis, and also by the determination of the

number of methoxyl groups present, which has shown that the base contains one more than aconitine.

Methyl benzaconine is a well crystallised base (m. p. 210—211°, corr.), soluble in alcohol ether and benzene, and most readily crystallised by adding light petroleum to its ethereal solution. It forms crystalline salts; the *hydrochloride* and the *hydrobromide* have been examined.

On hydrolysis, methylbenzaconine loses benzoic acid, forming a base which appears to be methyl aconine, but has not so far been completely investigated. Methyl benzaconine produces a well-marked physiological effect when administered to animals, but, unlike aconitine, it is not a powerful poison.

The authors are at present engaged in investigating the mechanism of the remarkable reaction which has led to the formation of this alkaloid, the acetyl group of aconitine being apparently replaced by methyl.

105. "The chemical inactivity of Röntgen rays." By H. B. Dixon and H. Brereton Baker.

The authors have investigated the question whether Röntgen rays are able to influence chemical change, either by starting it or by accelerating or diminishing it after it has been started by ordinary light. In all cases examined negative results were obtained. These were carbon monoxide and oxygen (dried and moist), hydrogen and oxygen, hydrogen and chlorine, carbon monoxide and chlorine, hydrogen sulphide and sulphur dioxide, solutions of sodium sulphite and oxygen, slow oxidation of phosphorus, decomposition of hydrogen peroxide.

106. "Colloidal chromsulphuric acid." By H. T. Calvert and T. Ewan.

By heating together 1 molecular proportion of chromium sulphate and 4—6 molecular proportions of sulphuric acid at 115° for one or two days, Reconra (*Ann. Chim. Phys.*, 1895, [7], 4, 516) has prepared a series of bodies having the formulæ:— $\text{Cr}_2(\text{SO}_4)_3 \cdot 4\text{H}_2\text{SO}_4$, $\text{Cr}_2(\text{SO}_4)_3 \cdot 5\text{H}_2\text{SO}_4$, &c., which he calls chromopolysulphuric acids. These compounds dissolve readily in water, yielding yellowish-green, opalescent solutions. The behaviour of these solutions makes it appear probable that the chromosulphuric acids do not exist in them as such, but are hydrolysed, forming a colloidal substance, $\text{Cr}_2(\text{SO}_4)_3 \cdot \text{H}_2\text{SO}_4$, and free sulphuric acid. Reconra does not attempt to decide whether this is so or not. Experiments recently made by W. R. Whitney (*Zeit. physikal. Chem*, 1896, 20, 59) lead him to the conclusion that the above view is the correct one. The following

experiments, which were carried out in part more than a year ago, may be of interest as yielding further evidence in the same direction.

The green, opalescent solutions were filtered through porous earthenware (a "Pasteur-Chamberland candle" was used). A dark green, gelatinous deposit remained on the outside of the pot; the filtrate was almost colourless, and contained a mere trace of chromium together with the excess of sulphuric acid over and above that required to form the compound $\text{Cr}_2(\text{SO}_4)_3 \cdot \text{H}_2\text{SO}_4$. There was thus no doubt that the gelatinous substance removed from the solution possessed this composition; the same body was obtained from acids of the formulæ $\text{Cr}_2(\text{SO}_4)_3 \cdot 3\text{H}_2\text{SO}_4$ and $\text{Cr}_2(\text{SO}_4)_3 \cdot 5\text{H}_2\text{SO}_4$.

The following are the details of the experiments. Chromium sulphate was prepared by reducing chromic acid with pure alcohol in presence of sulphuric acid (Traube, *Annalen*, 1848, **66**, 168). It was recrystallised by precipitating its aqueous solution with alcohol, and dried in a vacuum. On prolonged heating to 200° it lost about 11 mols. of water; a determination of the sulphuric acid, however, showed that its formula was $\text{Cr}_2(\text{SO}_4)_3 \cdot 12 \cdot 75\text{H}_2\text{O}$.

I. One molecule of this salt was mixed with 3 mols. of concentrated sulphuric acid, and the mixture heated to $115\text{--}120^\circ$ for seven days. The mass dissolved readily in water; 10 c.c. of the pale green, opalescent solution yielded 0.0596 gram Cr_2O_3 and 0.5177 gram BaSO_4 . The liquid was then filtered through the moist porous pot by evacuating the latter internally; the first portion of the filtrate was rejected. Since the filtration was very slow the filtrate probably became somewhat too concentrated by evaporation. 10 c.c. of the filtrate gave 0.1674 gram BaSO_4 . The solution therefore contained: $\text{Cr}_2(\text{SO}_4)_3 + 2 \cdot 68\text{H}_2\text{SO}_4$, and the filtrate contained $\text{Cr}_2(\text{SO}_4)_3 + 1 \cdot 8\text{H}_2\text{SO}_4$. The composition of the gelatinous compound was $\text{Cr}_2(\text{SO}_4)_3 \cdot 0 \cdot 84\text{H}_2\text{SO}_4$.

II. This experiment was made in the same way, the results being:—The original solution contained: $\text{Cr}_2(\text{SO}_4)_3 + 5 \cdot 00\text{H}_2\text{SO}_4$; the filtrate contained $\text{Cr}_2(\text{SO}_4)_3 + 4 \cdot 25\text{H}_2\text{SO}_4$. The substance removed was thus: $\text{Cr}_2(\text{SO}_4)_3 + 0 \cdot 75\text{H}_2\text{SO}_4$.

The formation of the colloidal substance was not observed when 1 molecular proportion of chromium sulphate was heated with 1 molecular proportion of sulphuric acid for two weeks.

ADDITIONS TO THE LIBRARY.

I. *By Purchase.*

The Liquefaction of Gases. Papers by Michael Faraday, F.R.S. (1823—1845), with an Appendix, consisting of Papers by Thomas Northmore. On the Compression of Gases (1805—1806). 79 pp. London 1896.

(Alembic Club Reprints, No. 12.)

Lacroix, A. *Minéralogie de la France et de ses Colonies*. Tome premier. xx+723 pp. Paris 1893—95.

Liebisch, Theodor. *Grundriss der Physikalischen Krystallographie mit 898 Figuren im Text*. viii+506 pp. Leipzig 1896.

II. *Donations.*

Bamber, M. Kelway. *A Text-Book on the Chemistry and Agriculture of Tea, including the growth and manufacture*. 258+xxii pp. Calcutta 1893. From the Author

Clowes, Frank, and Coleman J. Bernard. *Elementary Practical Chemistry and Qualitative Analysis*. xvi+224 pp. London 1896.

From the Authors.

Cornish, Vaughan, M.Sc. *Practical Proofs of Chemical Laws: a Course of Experiments upon the Combining Proportions of the Chemical Elements*. xii+92 pp. London 1895. From the Author.

Forli. *Annali della R. Stazione Agraria di Forli*. Fascicoli xxi, xxii, xxiii, 1892—1894. Modena and Forli 1894—1895.

From the Station.

Heusler, Dr. Fr. *Die Terpene*. xii+183 pp. Braunschweig 1896.

From the Author.

Dr. Lassar-Cohn. *Chemistry in Daily Life*. Popular Lectures. Translated by MM. Pattison-Muir, M.A. With 21 woodcuts in text. x+324 pp. London 1896. From the Publishers.

Sanford, P. Gerald. *Nitro-explosives. A Practical Treatise concerning the Properties, Manufacture, and Analysis of Nitrated Substances, including the Fulminates, Smokeless Powders, and Celluloid*. xii+270 pp. London. From the Author.

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P R O C E E D I N G S

OF THE

C H E M I C A L S O C I E T Y .

EDITED BY THE SECRETARIES.

No. 169.

Session 1895-96.

The following are the abstracts of papers received during the vacation, and published in the Transactions.

107. "Contributions to the chemistry of phenol derivatives." By R. Meldola, F.R.S., G. H. Woolcott, and E. Wray.

In this paper the authors describe a number of new derivatives of phenol, pyrocatechol, guaiacol, &c., which have been prepared incidentally in the course of an investigation into the methods of synthesis of certain natural phenol derivatives such as eugenol, safrole, &c.

4-Chloro-3-nitrophenol from the corresponding nitroaminophenol by Sandmeyer's process. Whitish needles, m. p. 126—127°. Benzoyl derivative, m. p. 96—97°. Acetyl derivative, m. p. 83—85°.

Diacetyl-o-aminophenol (*o*-acetaminophenyl acetate) prepared by heating *o*-aminophenol with excess of acetic anhydride and dry sodium acetate. White prismatic needles, m. p. 123—124°, or with $1\frac{1}{2}$ H₂O, m. p. 76—77°. The nitro-derivative, obtained by nitrating the diacetyl compound by a mixture of ordinary and fuming nitric acid, gives, on hydrolysis, 5-nitro-2-aminophenol (Friedländer and Zeitlin, *Ber.*, 1894, **27**, 196).

2-Chloro-5-nitrophenol, obtained from the last nitroaminophenol by Sandmeyer's process. White needles, m. p. 118—119°. Benzoyl derivative, m. p. 127—128°.

2-Bromo-4-nitro-6-aminophenol, obtained by reducing the bromo-dinitrophenol, m. p. 118—119°, of Laurent and Körner by means of ammonium sulphide. Whitish needles, soluble in hot water; becomes brown on exposure to air; m. p. 162—163°. Both acid and basic in properties. Acetyl derivative; m. p. 194° with decomposition, can

be made to decompose at 204° by rapidly heating. Anhydro-base; by heating acetyl derivative with acetic anhydride, m. p. $146-147^{\circ}$. Methyl ether (bromonitro-*o*-anisidine), yellow needles, m. p. $120-121^{\circ}$. Diazoxide; yellow needles, decomposing point $152-153^{\circ}$.

2-*Chloro-4-nitrophenol*, obtained from 4-nitro-2-aminophenol (Laurent and Gerhardt, *Annalen*, 1850, **75**, 68) by Sandmeyer's process. Benzoyl derivative, m. p. 135° . Acetyl derivative, m. p. 63° .

4-*Nitro-2-aminoanisole*, prepared by reducing 2:4-dinitroanisole in alcoholic solution with ammonium sulphide. Orange needles (from water), m. p. 118° . Acetyl derivative, m. p. $174-175^{\circ}$.

5-*Nitro-2-aminoanisole*, prepared by hydrolysing the acetyl derivative obtained by nitrating *o*-nitroacetanilide (Mühlhauser, *Annalen*, 1881, **207**, 242). Yellow needles (from water), m. p. $139-140^{\circ}$. Acetyl derivative, m. p. $145-146^{\circ}$.

Nitroaminoguaiacol, obtained by reducing dinitroguaiacol, m. p. 121° (Herzig, *Monatsh.*, 1882, **3**, 825) with ammonium sulphide; brown needles, both acid and basic; decomposing point 182° . Acetyl derivative; decomposing point $224-226^{\circ}$. Diacetyl derivative; decomposing point 204° . Diazoxide; orange needles, exploding sharply at $169-170^{\circ}$. Constitution probably 4-nitro-6-amino-2-methoxyphenol.

5-*Nitro-3-aminopyrocatechol*, obtained by reducing the dinitropyrocatechol of m. p. 164° (Nietzki and Moll, *Ber.*, 1894, **26**, 2183) with ammonium sulphide; acid and basic ochreous needles, m. p. $220-221^{\circ}$ with decomposition. Diazoxide; flat, golden needles, exploding sharply at $159-160^{\circ}$. Soluble in alkali, with a purple colour. The authors point out that generally the formation of diazoxides may be taken as evidence that the amino- and hydroxy-groups are ortho with respect to each other, and they consider the formula of the compound to be 5-nitro-3-amino-2-hydroxyphenol.

108. "Action of light on amyl alcohol." By A. Richardson, Ph.D., and Emily C. Fortey, B.Sc.

The authors have investigated the action of light on a number of alcohols in presence of oxygen. The alcohols used were obtained from Kahlbaum, and carefully purified by redistillation. It was found that whereas in the case of methyl, ethyl, propyl, and butyl alcohols an exposure extending over many months failed to produce any apparent change, the alcohols remaining neutral to litmus and containing no hydrogen peroxide, amyl alcohol gave strongly acid reactions and contained large quantities of hydrogen peroxide after only a few days' exposure. A similar change seemed to take place in the case of octyl alcohol, but to a very much smaller extent. The action of light on amyl alcohol was therefore studied in detail.

Amyl alcohol was exposed to light in presence of excess of water

and of oxygen for a few days. A portion of the water was then tested with titanio acid, when the presence of hydrogen peroxide was shown by a deep brown coloration. Another portion was shaken with pure ether and potassium bichromate, when the ether assumed an intensely blue colour, leaving no doubt as to the presence of hydrogen peroxide in the solution. In another experiment liquid water was absent, amyl alcohol being exposed in presence of moist oxygen. Two days' exposure sufficed to bring about the formation of hydrogen peroxide, as shown by the titanio acid test. A third experiment was made with dry alcohol. A sample of amyl alcohol dried first from quicklime, then by distillation from sodium, was sealed in a bent tube containing oxygen and phosphorus pentoxide (care being taken not to allow the liquid to wet the pentoxide), and kept in the dark for seven weeks. After exposure, the alcohol was found to contain abundance of hydrogen peroxide.

The other products formed were then examined. The acidity was found to be due to the presence of valeric acid, and the absence of carbon dioxide leads to the conclusion that the change is one of a comparatively simple nature, not involving the breaking down of the molecule. It seems, then, that the products formed by the oxidation of amyl alcohol in presence of sunlight and oxygen only differ from those formed when other oxidising agents are used in that hydrogen peroxide is formed instead of water. The change may, therefore, be represented by the following equation:— $2C_5H_{11}OH + 3O_2 = 2C_5H_9COOH + 2H_2O_2$.

It was found that the presence of sunlight was essential to the change, a sample of amyl alcohol kept in the dark at 100° for nine days remaining neutral to litmus, and containing no hydrogen peroxide.

109. "Note on the action of light on ether." By A. Richardson, Ph.D., and Emily C. Fortey, B.Sc.

Ether prepared from pure alcohol and pure sulphuric acid, and then treated with potassium bichromate, was dried by repeated distillation from phosphorus pentoxide in a specially constructed apparatus by means of which samples could be sealed for use without contact with air. The ether was then exposed in a tube containing oxygen which had been dried by contact with phosphorus pentoxide for many weeks. After three days' exposure, the liquid gave a well marked peroxide reaction when tested with titanio acid.

In order to investigate the other products formed, a sample of ether was exposed for many weeks in presence of water and oxygen. It was then rich in hydrogen peroxide, and gave an acid reaction with

litmus. The neutralised solution was distilled on the water bath. The distillate, consisting chiefly of ether, was also proved to contain aldehyde by its reducing action on ammoniacal silver nitrate, and by its restoring the colour to rosaniline hydrochloride, decolorised by sulphurous acid. The residue in the distilling flask gave a distinct red colour with ferric chloride, and the characteristic smell of ethyl acetate on warming with alcohol and sulphuric acid, leaving no doubt as to the formation of acetic acid. No carbon dioxide was formed in the reaction, which may, therefore, probably be represented by the equation $2(\text{C}_2\text{H}_5)_2\text{O} + 5\text{O}_2 = 4\text{C}_2\text{H}_4\text{O}_2 + 2\text{H}_2\text{O}_2$, aldehyde being an intermediate product.

Here, again, hydrogen peroxide takes the place of the water which is formed when ordinary oxidising agents are used.

110. "The constitution of lapachol and its derivatives. Part III. The structure of the amylene chain." By Samuel C. Hooker.

Experimental proof is brought to show that the amylene chain must be written $-\text{CH}_2\cdot\text{CH}:\text{C}(\text{CH}_3)_2$, and not $-\text{CH}:\text{CH}\cdot\text{CH}(\text{CH}_3)_2$, as has been previously assumed. In accordance with this change, new formulæ are proposed for various lapachol derivatives.

111. "Lomatiol." By Samuel C. Hooker.

The colouring matter obtained by Rennie (*Proc.*, **11**, 150) is a hydroxyisolapachol.

112. "Contributions to the knowledge of the β -ketonic acids. Part II." By Siegfried Ruhemann, Ph.D., M.A., and C. G. L. Wolf, B.A., M.D.

The authors describe the products of the action of ethylic chlorofumarate on ethylic benzoylacetate, and on the sodium derivative of ethylic methylacetoacetate; of the hydrolysis of ethylic methylfurfurandicarboxylate; and of the action of ethylic sodioacetoacetate on ethylic α -chlorocrotonate.

113. "Formation of pyrazolone derivatives from chlorofumaric acid." By Siegfried Ruhemann, Ph.D., M.A.

The author describes the products of the action of hydrazine and phenylhydrazine on ethylic chlorofumarate. In the former case, ethylic 5-pyrazolone-3-carboxylate is formed, identical with v. Rothenburg's compound (*J. pr. Chem.*, 1895, **51**, 53), in the latter an ethereal salt of bis-phenylpyrazolonecarboxylic acid. Their properties are described.

114. "Studies of the terpenes and allied compounds. Note on ketopinic acid—a product of the oxidation of the solid hydrochloride (chlorocamphydrene) prepared from pinene." By Henry E. Armstrong.

The acid described has the formula $C_{10}H_{14}O_3$, and is obtained by the interaction of chlorocamphydrene and the strongest nitric acid. It melts at 234° (uncorr.). Baric, calcic, and methylic salts are described, as well as a hydrazone (m. p. 146°) and a hydroxime (m. p. 216°). Ketopinic acid appears to be a saturated ketomonocarboxylic acid.

115. "Acid compounds of natural yellow colouring matters. Part II." By A. G. Perkin.

In a previous communication by Perkin and Pate (Proc., 1895, 11, 126), it was shown that when treated with mineral acids in the presence of acetic acid, quercetin, rhamnetin, rhamnazin, fisetin, and morin, yielded crystalline compounds, the formula of which is generally represented as an addition product of one molecule of acid to one molecule of colouring matter. It has since been shown that luteolin and myricetin behave similarly, and there can be little doubt that all these colouring matters belong to the so-called quercetin group. In this paper certain of these compounds not previously examined are described, viz.: Quercetin hydrochloride, $C_{15}H_{10}O_7 \cdot HCl$; morin hydriodide; $C_{15}H_{10}O_7 \cdot HI$, and luteolin hydriodide, $C_{15}H_{10}O_6 \cdot HI$. It is also shown that whereas quercetin tetramethyl ether, resembles the mono-methyl ether of rhamnetin in reacting with sulphuric acid, and not with the haloid acids, dibromo-quercetin and tetrabromo-morin yield no compounds with mineral acids. The other known members of the quercetin series are dioxyflavone (Friedländer and Rudt, *Ber.*, 1896, 878) and chrysin, the colouring matter of poplar buds. The former has been shown by its discoverers to yield acid compounds, but, on examination, the latter was found to be devoid of this property. Various members of the ketone group (gallacetophenone, alizarine, and maclurin), of the xanthone group (gentisin, euxanthone, datiscetin), and of the anthraquinone group, were examined in this respect, but yielded no compounds with mineral acids. Catechin and kinoïn also, the latter a constituent of malabar kino, did not react.

For the constitution of the acid compounds two schemes are put forward, the first a similar one to that suggested by Nietzki and Schröber (*Ber.*, 1895, 50) for the phthaleine salts, and a second depending upon the saturation of the ethylene bond in the γ -pyrone ring.

It is considered probable that this reaction is characteristic of the

quercetin group, and will thus be of service for distinguishing its members from the other classes of non-nitrogenous, yellow, mordant dye-stuffs which are at present known to exist.

116. "Studies on citrazinic acid. Part IV." By W. J. Sell, M.A.

The author has employed Tiemann and Reimer's reaction (*Ber.*, 1876, 9, 423, 824) to introduce the aldehyde group into hydroxyl derivatives of pyridine, and has isolated and analysed the disodium salt of the monaldehyde of citrazinic acid, the monaldehyde acid, the oxime of the monaldehyde acid, and the phenylhydrazine salt of the hydrazone.

117. "The action of certain acidic oxides on salts of hydroxy-acids. III." By G. G. Henderson, D.Sc., M.A., and John M. Barr.

By the prolonged boiling of antimonious oxide in an aqueous solution of the primary malate, *ammonium antimonio-malate* was obtained, $2\text{Sb}_2\text{O}(\text{C}_4\text{H}_4\text{O}_5\text{NH}_4)_4 \cdot \text{Sb}_2\text{O}(\text{C}_4\text{H}_5\text{O}_5)_4 \cdot 20\text{H}_2\text{O}$, resembling the potassium salt already described (*Trans.*, 1895, 1030). It forms large, colourless crystals, easily soluble in water, and decomposes when heated to about 115° , or when its aqueous solution is boiled for a short time, except in presence of excess of the oxide.

Antimonious oxide dissolved slowly in a boiling solution of sodium hydrogen malate, and, on adding alcohol, a syrup was precipitated, which consisted principally of the sodium compound. However, the pure salt could not be obtained in a crystalline condition.

While arsenious oxide dissolved freely in solutions of primary sodium and ammonium malates, salts corresponding to the antimonio-malates could not be prepared in a pure state, owing to the instability of the products, although an impure ammonium compound was obtained.

Ammonium antimonio-mucate, $\text{SbO}(\text{NH}_4)\text{C}_4\text{H}_5\text{O}_5 \cdot 3\text{H}_2\text{O}$, was prepared by prolonged boiling of the oxide with a solution of the primary mucate and repeated recrystallisation of the product. It is a white, finely crystalline powder, sparingly soluble in cold, but fairly easily soluble in hot water. In its other properties it closely resembles the potassium salt already described (*loc. cit.*). The *sodium salt*, $\text{SbONaC}_4\text{H}_5\text{O}_5 \cdot 3\text{H}_2\text{O}$, prepared similarly, is also a white crystalline powder, only differing from the others in its greater solubility in water. On addition of barium acetate to a solution of the sodium salt what appeared to be a slightly impure barium salt was gradually precipitated in the form of a white powder.

Attempts to prepare arsenio-mucates of sodium and ammonium were not successful, and failure also attended our efforts to obtain

compounds of the alkali salts of mandelic acid with antimonious and arsenious oxides respectively.

Salicylic and gallic acids were then taken as examples of phenol acids, but experiment showed that neither antimonious nor arsenious oxide entered into reaction with any of the alkali salts of these acids.

Molybdenum trioxide was found to dissolve in boiling aqueous solutions of primary tartrates, forming compounds with them. *Sodium molybdi-tartrate*, $\text{MoO}_3(\text{NaC}_4\text{H}_4\text{O}_6)_2 \cdot 3\text{H}_2\text{O}$, was obtained in the form of a white crystalline powder, easily soluble in cold water, and decomposed on exposure to light or to a temperature of 96° , and also when its aqueous solution is boiled for some time. The *potassium salt* is also a crystalline powder, very similar in properties to the sodium salt, but less stable. The ammonium salt was only obtained in the form of a gelatinous precipitate.

Sodium tungsti-tartrate, $\text{WO}_3(\text{NaC}_4\text{H}_4\text{O}_6)_2 \cdot 5\text{H}_2\text{O}$, was prepared by dissolving tungsten trioxide in a boiling aqueous solution of the primary tartrate, excess of the latter being used. It crystallises in white plates, easily soluble in water, and decomposed when heated to about 110° , or when its aqueous solution is boiled for any length of time. The *potassium salt*, $\text{WO}_3(\text{KC}_4\text{H}_4\text{O}_6)_2 \cdot 4\frac{1}{2}\text{H}_2\text{O}$, and the *ammonium salt* are also crystalline, the former closely resembling the sodium salt in properties, the latter being very unstable in presence of water. The *barium salt*, $\text{WO}_3(\text{C}_4\text{H}_4\text{O}_6)_2 \cdot \text{Ba}$, is precipitated as a white, insoluble powder when barium acetate is added to a solution of the sodium salt.

Silicon dioxide, used in the form of gelatinous silicic acid, apparently does not react directly with primary tartrates, but titanium dioxide dissolves in solutions of these salts, yielding substances which are being examined. It remains to be tried whether other acidic oxides also react with tartrates and salts of other hydroxy-acids.

118. "Note on γ -acetobutyric acid, $\text{CH}_3\text{CO} \cdot \text{CH}_2\text{CH}_2\text{CH}_2\text{COOH}$." By W. H. Bentley and W. H. Perkin, Jun.

The properties of this acid were carefully investigated in order to enable the authors to compare it with a ketonic acid obtained from sulphocamphylic acid. It was prepared by the hydrolysis of ethylic acetyl glutarate (Wolff, *Annalen*, 1833, 216, 129), the method of preparation being improved in some respects.

The oxime (m. p. $104-105^\circ$) and the *semicarbazone* (m. p. 174°) are the most characteristic derivatives; when oxidised with nitric acid, aceto-butyric acid yields succinic acid.

119. "Some derivatives of propionic acid, of acrylic acid, and of glutaric acid." By W. H. Perkin, jun.

This paper describes in the first place the results of the investigation of *dimethylacrylic acid*, $(\text{CH}_3)_2\text{C}:\text{CH}\cdot\text{COOH}$; *trimethylacrylic acid*, $(\text{CH}_3)_2\text{C}:\text{C}(\text{CH}_3)\cdot\text{COOH}$; and *isopropylacrylic acid*, $(\text{CH}_3)_2\text{CH}\cdot\text{C}(\text{CH}_3)\cdot\text{COOH}$.

The ethereal salt of the former acid, when digested in alcoholic solution with the sodium compound of ethylic malonate, yields *ethylic dimethylpropanetricarboxylate*, $(\text{COOC}_2\text{H}_5)_2\text{CH}\cdot\text{C}(\text{CH}_3)_2\cdot\text{CH}_2\cdot\text{COOC}_2\text{H}_5$ (compare Auwers, *Ber.*, 1895, **28**, 1130; *Annalen*, 1896, **292**, 145), (b. p. 203° , 60 mm.), from which, by hydrolysis and elimination of carbon dioxide, $\text{COOH}\cdot\text{CH}_2\cdot\text{C}(\text{CH}_3)_2\cdot\text{CH}_2\cdot\text{COOH}$, $\beta\beta$ -*dimethylglutaric acid*, was obtained. This acid melts at 101° , and gives an anhydride melting at 124° and an anilic acid melting at 134° .

Trimethylacrylic acid, together with *isopropylacrylic acid*, results from the action of alkalis on *ethylic α -bromo- $\alpha\beta$ -trimethylpropionate*, $\text{CH}(\text{CH}_3)_2\cdot\text{CBr}(\text{CH}_3)\cdot\text{COOC}_2\text{H}_5$. The former is a crystalline compound which melts at 70 – 71° , and from which the following derivatives have been prepared.

$\alpha\beta$ -*Dibromo- $\alpha\beta\beta$ -trimethylpropionic acid*, $\text{CBrMe}_2\cdot\text{CBrMe}\cdot\text{COOH}$ (m. p. 188°).

β -*Bromo- $\alpha\beta\beta$ -trimethylpropionic acid*, $\text{CBr}(\text{CH}_3)_2\cdot\text{CH}(\text{CH}_3)\text{COOH}$ (m. p. 88°).

β -*Iodo- $\alpha\beta\beta$ -trimethylpropionic acid*, $\text{CI}(\text{CH}_3)_2\cdot\text{CH}(\text{CH}_3)\cdot\text{COOH}$ (m. p. 88°).

When the mixed ethereal salts of trimethylacrylic and isopropylacrylic acids (as obtained by the action of quinoline on ethylic α -bromotrimethylpropionate) are digested with the sodium compound of ethylic malonate, the ethylic isopropylacrylate only enters into the reaction with formation of *ethylic isopropylpropanetricarboxylate*, $(\text{COOC}_2\text{H}_5)\cdot\text{CH}_2\cdot\text{CH}_2\cdot\text{C}(\text{COOC}_2\text{H}_5)_2\cdot\text{CH}(\text{CH}_3)_2$ (b. p. 208 – 210° at 45 mm.), the ethylic trimethylacrylate remaining apparently unattacked. $(\text{COOH})\cdot\text{CH}_2\cdot\text{CH}_2\cdot\text{C}(\text{COOH})_2\cdot\text{CH}(\text{CH}_3)_2$, *isopropylpropanetricarboxylic acid*, crystallises in colourless needles, which melt at 265° with decomposition into carbon dioxide and *isopropylglutaric acid*, $\text{COOH}\cdot\text{CH}_2\cdot\text{CH}_2\cdot\text{CH}(\text{COOH})\cdot\text{CH}(\text{CH}_3)_2$. This acid melts at 95° , and gives an *anhydride* at 53° and an *anilic acid* melting at 158 – 159° ; its constitution is proved by its synthesis from ethylic isopropylmalonate and ethylic β -iodopropionate.

This paper contains also an account of a number of experiments on the action of phenoxyethylbromide, $\text{C}_6\text{H}_5\cdot\text{O}\cdot\text{CH}_2\cdot\text{CH}_2\text{Br}$, on the sodium compounds of ethylic dimethylpropanetricarboxylate and ethylic isopropylpropanetricarboxylate.

120. "On the action of chloroform and potash on metamidobenzoic acid." By W. J. Elliott, M.A.

By the action of aqueous potash and chloroform on metamidobenzoic acid, a compound is obtained which is insoluble in all solvents, reduces Fehling's solution, and gives with phenylhydrazine a red compound, which is not a hydrazone, but has the properties of an azo-compound.

The compound has the empirical formula $C_8H_7NO_3$, and the author suggests the constitutional formula

$$\begin{array}{ccc} \text{NH}_2 & & \text{NH}_2 \\ | & & | \\ \text{C}_6\text{H}_3\cdot\text{CHOH}\cdot\text{CO}\cdot\text{C}_6\text{H}_3 & , & \text{that} \\ | & & | \\ \text{COOH} & & \text{COOH} \end{array}$$

is di-amido-di-carboxy-benzoin. When boiled with water for some time, the compound is oxidised, yielding a solution of metamidobenzoic acid. With phenylhydrazine, metamidobenzoic acid and a compound having the empirical formula $C_7H_5N_2$, are formed. The author suggests the formation of an osazone, which is reduced, by the hydrogen set free, to metamidobenzoic acid and a disazo-compound of the formula $C_6H_5\cdot N:N\cdot CH:CH\cdot N:N\cdot C_6H_5$.

November 5th, 1896. Mr. A. G. Vernon Harcourt, President, in the Chair.

Messrs. J. B. Knight, S. G. Rosenblum, J. A. Craw were formally admitted Fellows of the Society.

The following certificates were read for the first time:—

Henry Edward Aykroyd, Ashwell, Toller Lane, Bradford; William Ballingall, Ardarrock, Dundee; Charles Bathurst, Junr., Lydney Park, Gloucestershire; Lauritz Hansen Bay, The Grammar School, Carlisle; Charles Edward Browne, 2, Hinton Villas, Cheltenham; George Harold Cross, B.Sc., Balliol College, Oxford; William Duncan, Royal Dispensary, West Richmond Street, Edinburgh; Walter John Elliott, M.A., 5, Dover Place, Clifton, Bristol; John Thomas Fleet, Rugby, Warwickshire; George George, Regent Street, Kingswood, near Bristol; Arthur Croft Hill, Trinity College, Cambridge; Charles Alexander Hill, Hawthorns, South Road, Clapham Park; John William Hinchley, Baggeholme Road, Lincoln; William Trevor Lawrence, B.A., Ph.D., 57, Prince's Gate, S.W.; Robert Dexter Littlefield, 23, Wightman Road, Harringay, N.; Thomas Henry Lloyd, Penygraig, Pontypridd; Thomas William Lockwood,

Heckmondwike; Edward Seaborn Marks, 111, Cromwell Road, S.W.; Arthur Stanley Mayfair, Avenue House, Beverley Road, Hull; William M. Miller, Prye Estate, Wellesley, Penang, Straits Settlements; Landon Clarence Moore, 19, Mecklenburgh Square, W.C.; Francis Ambrose Moss, Menzies, Western Australia; Herbert William Moss, Broken Hill Proprietary Company, Limited, Port Pirie, South Australia; Joseph Terrence de la Mothe, Grand Bacolet Estate, St. Andrew's Parish, Grenada, West Indies; Alexander Henry Mitchell Muter, The Châtelet, Horley, Surrey; William Harrison Pearsall, The School House, Dalton-in-Furness; Henry William Potts, Eurca, Victoria; Frederick Belding Power, 21, Queen Square, Bloomsbury, W.C.; William Russell, Summerlie, Coatbridge, N.B.; Herbert Cecil Seabrooke, The Echoes, Grays, Essex; William Horace Sodean, B.Sc., 25, Shore Road, South Hackney, N.E.; Charles Thompson, Grammar School, Coatham, Redcar; William Henry Walker, Stafford Street, Willenhall, Staffs.; William Watson, M.A., School House, Kingsbridge, South Devon; Edwin Whitfield Wheelwright, B.Sc., Ph.D., The Oaklands, Warley, Oldbury, near Birmingham; John Harrison Wigner, Ph.D., 58, Breakspears Road, St. John's, S.E.

Of the following papers, those marked * were read.

*121. "The constitution of the so-called nitrogen iodide. By F. D. Chattaway, M.A.

From the beginning of the present century, the black explosive compound formed when a solution of ammonia acts upon iodine, has almost continuously engaged the attention of chemists. No definite conclusion as to its constitution has, however, been arrived at, although, from time to time, different formulæ have been assigned to it, while, on account of its apparently variable composition, several distinct compounds have been supposed to exist.

The formulæ NI_3 , NI , NH_2I , NHI_2 , and NH_3NI_3 , have been adopted by various chemists, while others have suggested that a series of different but allied substances exist, derived either from NH_3 , or a hypothetical substance, $\text{H}_3\text{N}:\text{NH}_3$, by replacement of hydrogen.

A number of experiments made with this substance with a view to the synthesis of hydrazine derivatives having given negative results, an investigation of the compound itself was undertaken.

Nitrogen iodide cannot be obtained dry in a condition suitable for analysis, so that all experiments have to be conducted with an unknown quantity and in presence of water. It is best prepared by adding a solution of iodine in potassium iodide to an excess of a

strong solution of ammonia, when it is precipitated as a soft black powder.

Many analyses have shown that its composition does not vary according to the mode of preparation, provided that sufficient care is taken to remove unchanged ammonia, iodine, and the various products of the action. The substance always yields, on decomposition, ammonia and iodine, 1 mol. of ammonia being set free to 2 atoms of iodine. The variations of composition which have been observed are probably due to the substance not having been properly freed from ammonia or iodine, or to a decomposition of greater or less extent having taken place during the treatment of the substance after precipitation. If it be continuously washed with water, all the nitrogen can be removed as ammonium salts, practically pure iodine alone being left. This seems a sufficient explanation of the apparent existence of a series of compounds.

Nitrogen iodide has always been assumed to be a substitution derivative, mainly on the ground that in its preparation a large amount of ammonium iodide is formed.

This, however, is not the sole other product, ammonium hypoiodite also being produced, and, further, more than half the total iodine employed can be obtained in the nitrogen iodide produced. This could not happen if it were a substitution product.

A number of other facts, also, seem to show that it cannot be a substituted ammonia; for example, the invariable production of ammonia and never of any nitrogen compound containing oxygen in its decomposition by various agents; its formation only from free ammonia, and never from ammonium salts; the fact that iodine does not substitute in NH_2 groups, and the production of ammonium iodide when it explodes.

Whenever it is decomposed, ammonia and iodine are always liberated; these may be free or partially combined together, or they may react with the agent effecting the decomposition. An excess of water decomposes the substance, yielding, if light be excluded, ammonium iodide and hypoiodite and free iodine. This action explains the decomposition of the compound by prolonged washing, and the consequent accumulation of iodine in the residue. The ammonium iodide and hypoiodite formed can dissolve a little of the liberated iodine, but a certain amount cannot thus be taken into solution, and consequently remains behind mixed with the undecomposed compound. The percentage of iodine in the residue therefore continually increases, and ultimately only a small quantity of practically pure iodine is left behind.

Potash and soda very easily decompose the substance, liberating ammonia and forming iodide and hypoiodite, or if the solution

be heated, iodide and iodate. The oxides of lead and silver suspended in water act similarly, ammonia is evolved, and iodide and iodate of the metal formed.

Finely divided metals appear to assist the action of the water by combining with the liberated iodine.

Acids, generally speaking, decompose the compound, liberating iodine and ammonia, with the latter of which they combine. The action of hydrochloric acid is peculiar; it seems to form, at first ammonium iodide and iodine chloride.

All substances capable of reacting with iodine at once decompose nitrogen iodide, yielding, in addition to ammonia, the same products that they yield with iodine itself.

Sulphuretted hydrogen forms ammonium iodide and hydriodic acid, while sulphur is precipitated. Sulphurous acid gives hydriodic acid, and ammonium sulphate. Sodium thiosulphate liberates ammonia, and forms sodium iodide and sodium tetrathionate. The lower oxides of arsenic and antimony are converted into the higher, with liberation of ammonia and formation of hydriodic acid. Potassium cyanide sets free ammonia, and forms potassium iodide and cyanogen iodide.

On the whole, therefore, it seems that a single substance is formed by the action of ammonia on iodine, and that in this one atom of nitrogen is associated with two atoms of iodine. Whether the simplest formula that can be given to the substance is NHI_2 or NH_3I_2 can only be finally settled by a very careful investigation of all its reactions under the most varied conditions; but at present the formula NH_3I_2 seems best to accord with the reactions of the substance and express the known facts regarding it.

*122. "The carbohydrates of barley-straw." By C. F. Cross, E. J. Bevan, and C. Smith.

This is a continuation of investigations which were the subject of a recent communication (Trans., 69, 804). The furfuroid carbohydrates isolated by acid hydrolysis from the cereal celluloses afforded evidence of the existence of a hexose-pentose series of tissue constituents with a definite transition form corresponding with a pentose monoformal, *i.e.*, $\text{C}_5\text{H}_8\text{O}_3 < \text{O} > \text{CH}_2 = \text{C}_6\text{H}_{10}\text{O}_3$.

The methods leading to the recognition of this intermediate constitutional form have been applied to the plant taken at various stages of growth during the season 1896. The furfuroids were similarly isolated, and their constitution investigated by (1) osazones, (2) yeast fermentation, (3) the reaction with hydrogen peroxide previously described (*loc. cit.*).

The numbers obtained show a progressive variation. Thus, the

osazones are at first of high melting point (180—190°); the furfuroids are entirely broken down (fermented) by yeast in the neutralised solution, and the peroxide treatment shows negative results, *i.e.*, no evolution of carbon dioxide. From the flowering stage onwards the osazones fall in melting point; there is increasing resistance of the furfuroids to the action of yeast, and the characteristic reaction with hydrogen peroxide is observed, with increasing proportions of carbon dioxide formed.

These results point to the gradual transformation of a hexose into a pentose derivative.

At the same time the evidence is reviewed upon which these characteristic tissue constituents must be looked upon as having a special constitution or configuration *ab initio*, *i.e.*, they are assimilated or elaborated in the first instance with the constitutional features which determine their characteristic decompositions, *viz.*, (1) to furfural by the action of condensing acids, (2) to pentose derivatives as a normal incident of their life history in the plant.

***123. "The direct union of carbon and hydrogen." By William A. Bone, and David S. Jerdan.**

The authors have continued and extended the experiments of which they gave some account to the Society six months ago (Proc., 162, 61), and now are in a position to discuss their results more fully.

In their first communication they stated that they had produced methane by passing a slow current of hydrogen, free from hydrocarbon impurities, over purified carbon heated to bright redness in a porcelain tube placed inside a Fletcher injector furnace.

The products of the union of carbon with hydrogen at the temperature of the electric arc have been more thoroughly studied. The electric arc was formed between terminals of purified gas carbon in an atmosphere of dry hydrogen contained in a glass globe standing in a trough over mercury. The arc was maintained in hydrogen for an hour or more, and samples of the gas were drawn off at the end of 5, 15, 30, 45, &c., minutes in each experiment. These were afterwards analysed in a modified form of the McLeod gas-analysis apparatus.

The gases almost always contained small amounts of hydrocyanic acid, due, no doubt, to the presence of a little nitrogen in the hydrogen employed. Acetylene was always present in considerable quantities, and, in addition to this and any other unsaturated hydrocarbon, appreciable quantities of methane were found.

*124. "The explosion of acetylene with less than its own volume of oxygen." By William A. Bone and John C. Cain.

Continuing their earlier experiments (Proc., 142, 170), the authors have exploded mixtures of acetylene with from 29 to 95 per cent. of its own volume of oxygen in a leaden coil, some 5 metres long, having an internal diameter of 13 mm. The coil was closed at each end by a steel tap, and at one end a stout glass firing piece, into which two platinum wires were fused, was fixed between the steel tap and the end of the coil. The other end of the coil was connected with a mercury manometer, so that the pressure change inside the coil after an explosion could be determined.

The coil was immersed in a bucket of cold water, which served to rapidly cool the gases in the coil after an explosion. The coil was filled with the explosion mixture at the ordinary atmospheric pressure by displacement; the mixture was then fired by an electric spark passed across the wires at the firing piece. After the products of the explosion had cooled down to the temperature of the water surrounding the coil, the tap nearest the manometer was opened, and the pressure of the gases inside the coil was read off. In all cases a considerable increase in pressure, varying from 260 to 370 mm. of mercury, according to the mixture exploded, occurred.

Samples of the products of explosion were collected in each case, and these, together with the original mixtures of acetylene and oxygen, were carefully analysed in a modified form of the McLeod apparatus.

The products of explosion were found to consist chiefly of carbon monoxide and hydrogen, but in addition to these, small, but quite appreciable amounts of acetylene and carbon dioxide were invariably present.

In their earlier experiments, the authors suspected the presence of a small amount of methane among the products of explosion of certain mixtures of acetylene and oxygen; a more rigid examination of the products has, however, shown that methane is not present in any appreciable quantity.

Further experiments indicate that although the main resultant reaction may be expressed by such equations as (a) $C_2H_2 + O_2 = 2CO + H_2$; (b) $2C_2H_2 + O_2 = 2CO + 2H_2 + 2C$; (c) $3C_2H_2 + O_2 = 2CO + 3H_2 + 4C$, yet some steam is formed; this is evident from the fact that the ratio of the hydrogen to the carbon monoxide in the products is always less than the above equations require. Further, the presence of carbon dioxide in the products would be difficult to explain if no steam were produced.

The small percentages of nitrogen in the products of explosion are due to nitrogen contained in the original mixtures fired.

From these experiments, it is evident that when the electric arc is passed between carbon terminals in an atmosphere of hydrogen, acetylene and methane are both produced. Further, that the rate of formation of these two gases is fairly rapid during the first 15 minutes of the experiment, after which the rate falls, and finally, after about half an hour, a state of equilibrium between the hydrogen, acetylene and methane is attained. This equilibrium depends, to some extent, on the voltage employed.

These results led to the inference that methane and acetylene would both be decomposed by the electric arc, and that if the arc is passed long enough a similar state of equilibrium would be arrived at. This conclusion was fully borne out by subsequent experiments, in which pure acetylene or methane was subjected to the action of the electric arc passed between carbon terminals in the same apparatus as that employed in the experiments with hydrogen.

Both methane and acetylene are easily decomposed by the electric arc; during the first 10 minutes of the experiment, the gas (methane or acetylene, as the case might be) was very rapidly resolved into its elements, large flakes of carbon were formed in the neighbourhood of the terminals, and fell to the surface of the mercury below; the gas in the globe underwent a great increase in volume, much greater than could be accounted for by the mere expansion of the gas by the heat of the arc. A smoky flame rose from the terminals and filled the upper part of the globe. At the end of about 10 minutes, this extraordinary appearance subsided, after which the arc presented the same appearance as in the case of the hydrogen experiments. After the arc had passed for an hour, the experiment was stopped; samples of the gases were then collected and subsequently analysed.

The principal product in each case was hydrogen with about 9 per cent. of acetylene, and small quantities of methane, nitrogen, and hydrocyanic acid. In the experiment with acetylene, a minute quantity of naphthalene was also formed.

125. "The refraction constants of crystalline salts." By William Jackson Pope.

Although a large mass of accurate data concerning the refraction constants and molecular volumes of crystalline substances possessing one, two, or three principal indices of refraction has been collected, no successful attempt has hitherto been made to deduce a definite general relationship between the refraction constants and the composition of such salts. The author considers that the method used by Tutton of calculating a single molecular refraction constant for biaxial crystalline substances as the arithmetic mean of the molecular refractions for the two extreme refractive indices is not a

logical one, but that the molecular refraction should be calculated from the mean of all three refractive indices in such cases; the molecular refraction of uniaxial salts should be calculated from a refractive index which is one-third of the sum of the extraordinary index, and twice the ordinary refractive index.

The molecular refraction constants obtained in this way are, within the limits of experimental error, of an additive nature, so that it becomes possible to compile tables of atomic or equivalent refractions from which the molecular refraction of solid salts may be calculated additively in just the same way as is in general use for liquids.

The molecular refractions of some hundred or so salts have thus been calculated, both from the experimental data, and from the table of atomic refractions, and comparison shows a good agreement between both sets of numbers.

The author shows that the molecular refraction of a solid salt, calculated as above described, is not quite the same as that of the salt in aqueous solution. The influence of the solvent is naturally eliminated by dealing with the solid salt alone, and a physical method of deriving valuable information respecting the constitution of solid substances is thus obtained.

126. "Compounds of metallic hydroxides with iodine." By Theodore Rettie, B.Sc.

When iodine, dissolved in aqueous potassium iodide, is added to a solution of a magnesium salt, and potash is then carefully added to the mixed solutions, a dark brown precipitate is obtained. The author concludes that this and the somewhat similar precipitates obtained in an analogous manner with solutions of zinc, cadmium, and several other salts consist of metallic hydrates with a variable quantity of iodine carried down with them, forming compounds resembling lakes.

127. "Economical preparation of hydroxylamine sulphate." By E. Divers, M.D., F.R.S., and T. Haga, D.Sc.

Sodium nitrite yields nearly its own weight of hydroxylamine sulphate when carefully sulphonated, by the addition of sodium sulphite, and hydrolysed. In sulphonating, the solution must be kept slightly below 0° , and the sodium carbonate be closely in proportion to the nitrite of 1 mol. to 2 mols. The hydrolysis in its second stage must not be carried out at a boiling heat, because then much hydroxylamine is destroyed. At $90-95^{\circ}$ the hydrolysis is satisfactorily effected in two days. After neutralisation, the sodium sulphate is separated, and the hydroxylamine sulphate crystallised out. It is a non-deliquescent salt, soluble in three-fourths of its weight of water at 20° , and crystallises well.

127. "The reduction of nitrososulphates." By E. Divers, M.D., F.R.S., and T. Haga, D.Sc.

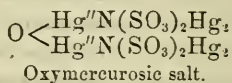
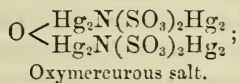
From a partly quantitative examination of the products of reduction of potassium nitrososulphate by sodium amalgam, it has been ascertained that they include hyponitrite, nitrous oxide, hydrazine, ammonia, nitrogen (probably), sulphite, sulphate, and amidosulphonate. Of 12 mols. of the salt it is estimated that six become amidosulphonate and nitrous oxide, four become sulphite and hyponitrite, and two become sulphate and partly hydrazine, partly nitrogen. The occurrence of hydrazine was discovered by Duden, in 1894; that of sulphate and amidosulphonate is new. The production of sulphate by the sodium is regarded by the authors as another proof that nitrososulphates have not a sulphonic constitution. The formation of amidosulphonic acid is attributed to the salt being a sulphate of a hydrogenisable radicle, and in this respect like no other known sulphate.

129. "Imidosulphonates. Part II." By E. Divers, M.D., F.R.S., and T. Haga, D.Sc.

Through the kindness of Dr. Raschig, the authors have been able to compare the contents of Berglund's Swedish papers on Imidosulphonic acid and amidosulphonic acid with their own results, which appeared in the Journal, in 1892 (Trans., 61, 943). They find that they have succeeded fairly well in making their own work supplementary to his and not a repetition of it. Where there has been overlapping, some interesting points are raised.

The normal sodium salt had been prepared by Berglund, but only by indirect methods, not by the sulphonation of sodium nitrite. The $\frac{2}{3}$ normal salt he did not prepare. There is disagreement as to the composition of the oxymercuric salt, and in the present paper new work is submitted, establishing fully, in the authors' judgment, the correctness of their formula, which makes the salt contain the bivalent group $-\text{HgOHgOHg}-$, found also in the oxymercuric sulphate, sulphite, and imidosulphonates. What the authors have described as the calcium sodium salt, Berglund mistook for the normal calcium salt. Among the new salts described in this paper are the true normal calcium and the true normal strontium, as well as the $\frac{2}{3}$ normal calcium salt. Berglund also mistook, it appears, the strontium sodium salt for the normal strontium salt. The mercuric sodium salt he duly recognised as such. The mercuric calcium salt has now been prepared, as also a compound of it with mercuric chloride, analogous to apatite, imidosulphonic acid holding the place of phosphoric acid. An oxymercurous salt described is of

interest on account of the contrast it shows between imidosulphonic acid and amidosulphonic acid, the latter, like ammonia, resolving mercurous salts into metal and mercuric salts. Lastly, mercurous salts have been prepared, remarkable in exhibiting a substitution, to varying extent, of the mercurous radicles in the preceding salt by mercuric radicles. The limit of this substitution is expressed in the following formulæ:—



130. "Amidosulphonic acid." By E. Divers, M.D., F.R.S., and T. Haga, D.Sc.

Except in the field of organic chemistry, nearly all that is known of amidosulphonic acid and its salts we owe to its discoverer, Berglund. Outside his work, in 1876, there is only to be mentioned that Fock has described its crystals and Raschig discovered a simple and excellent, though costly, method of preparing it by sulphonating hydroxylamine.

Of the additions now made by the authors to the knowledge of this acid, the following are the most prominent. Amidosulphonic acid is largely precipitated from its solutions by sulphuric acid. This fact makes the preparation of the acid from sodium nitrite very easy. Its preparation from this source is also very inexpensive; for when the nitrite has been sulphonated, and the product hydrolysed, the solution neutralised, and sodium sulphate crystallised out, there only remains to add some concentrated sulphuric acid, in order to get amidosulphonic acid almost pure, and in quantity equal in weight to at least three-fourths of the nitrite worked upon.

Amidosulphonic acid combines with mercuric oxide only to form a basic, insoluble compound. The acid precipitates the same compound from a solution of mercuric nitrate, which it can completely decompose, its mercury compound being insoluble in dilute nitric acid. More remarkable is the fact that this compound is soluble in alkalis. In its degree of basicity it agrees with the oxymereurous sulphate, sulphite, and imidosulphonates, and may, therefore, be formulated as $(\text{H}_2\text{NSO}_3\text{HgO})_2\text{Hg} \cdot 2\text{H}_2\text{O}$. But, since potassium hydroxide dissolves it without decomposing it, and that, regarding its amidosulphonic acid as an amine, it behaves exactly like a mercurammonium compound with Pesci's reagent (ammonium bromide), it may be taken to be, in alkaline solution at least, a sulphonated mercurammonium hydroxide, $\text{Hg}_3\text{N}_2(\text{SO}_3\text{K})_2(\text{OH})_2 \cdot 2\text{H}_2\text{O}$.

Amidosulphonic acid shows, again, a likeness to ammonia in serving to prevent precipitation of silver nitrate by potassium hydr-

oxide. When the amidosulphonate is not in excess, a bright, ochre yellow, colloidal substance can be precipitated from solutions of moderate dilution. Much water decomposes it, and forms with it a colloidal, brown solution (apparently of silver oxide). Its composition seems to be expressed by the formula AgHNSO_3K . Double decomposition between silver nitrate and potassium amidosulphonate does not take place when their solutions are mixed. The normal silver salt is well known.

The first action of heat upon amidosulphonic acid is very interesting. It melts at 205° , but not without decomposing, to a liquid which solidifies to a transparent vitreous mass, on cooling. The properties of this mass, which is formed without gain or loss in weight to the acid, show it to be composed of ammonium pyrosulphate and ammonium pyro-imidosulphonate in molecular proportions, along with 7—10 per cent. of unchanged acid. This transformation of the acid by heat is a striking example of intramolecular decomposition and of cumulative resolution in the direction of ammonia and water for hydration and salt formation. The behaviour of the mixed pyro-salts, when further heated, is described in the author's paper, but must be passed over here. Anhydrous salts of amidosulphonic acid are largely converted by heat into imidosulphonates and ammonia, but also into sulphates and gases. The decomposition of the barium salt, for instance, is nearly represented by the equation $3\text{Ba}(\text{SO}_3\text{NH}_2)_2 = 3\text{BaSO}_4 + \text{HN}(\text{SO}_3\text{NH}_4)_2 + \text{NH}_3 + \text{NS} + \text{N}$; but it is only this salt that yields nitrogen sulphide.

131. "Molecular conductivity of amidosulphonic acid." By J. Sakurai.

The molecular conductivity of amidosulphonic acid was determined by means of a Kohlrausch's universal bridge; the result shows that it is a strong monobasic acid, being nearly comparable with iodic acid. The author compares, at different dilutions, the degree of dissociation of amidosulphonic acid, $\text{O}_2\text{S} < \begin{smallmatrix} \text{NH}_2 \\ \text{OH} \end{smallmatrix}$, with that of sulphurous acid, $\text{O}_2\text{S} < \begin{smallmatrix} \text{H} \\ \text{OH} \end{smallmatrix}$, at the same dilutions, and shows that the former acid is much stronger than the latter. This result, he points out, is interesting from the fact that the influence of the NH_2 group upon the strength of organic acids generally is just of the opposite character, as is well known, and gives a confirmation of the view already published (Proc., 1894, 137) on the constitution of glycocin and other organic amido-acids. The fact that organic amido-acids are weaker than the non-amidated acids, whilst amido-sulphonic acid is stronger than sulphurous acid, of which it is the amido-derivative,

shows that mere presence of NH_2 does not diminish the strength of an acid. The difference can only be understood by assuming that, in the case of the former class of acids, the nitrogen of the basic group, $-\text{R}''\cdot\text{NH}_2$, is in combination with the hydrogen of the acid group, $-\text{CO}_2\text{H}$ or $-\text{SO}_3\text{H}$, thus $\text{H}_3\text{N}\cdot\text{R}''\cdot\text{CO}\text{O}$, or $\text{H}_3\text{N}\cdot\text{R}''\cdot\text{SO}_2\cdot\text{O}$, the dissociation of these molecules into H , on the one hand, and $\text{H}_2\text{N}\cdot\text{R}''\cdot\text{CO}\cdot\text{O}$, or $\text{H}_2\text{N}\cdot\text{R}''\cdot\text{SO}_2\cdot\text{O}$, on the other, occurring to a much less extent than in the case of the non-amidated acids, which dissociate into H and $\text{R}'\cdot\text{CO}_2$ or $\text{R}'\cdot\text{SO}_3$.

Finally, the author considers the dilution formulæ of electrolytes recently proposed by Rudolphi (*Zeit. physikal. Chem.*, 1895, **17**, 385) and van't Hoff (*Zeit. physikal. Chem.*, 1896, **13**, 300), and shows that his results are in agreement with these formulæ.

132. "The physiological action of amidosulphonic acid." By Oscar Loew, Ph.D.

Amidosulphonic acid, applied as its calcium or sodium salt, proves to be noxious to the life of phænogamous plants, but not to algæ, or to the lower fungi. It is not poisonous to the lower aquatic forms of animal life, such as Infusoria, Rotatoria, Copepoda; and, from experiments made by Prof. D. Takahashi, it proves to be also not poisonous to vertebrate animals, such as the dog and the frog. That its poisonous action should be confined to flowering plants is a point of much interest.

133. "How mercurous and mercuric salts change into each other." By S. Hada, B.Sc.

By the results of numerous experiments, the ways are shown by which mercuric salts in presence of water become mercurous, and mercurous salts become mercuric. Very much has been observed already by others concerning such a common subject, but the statements based on past experience have been uncertain and even contradictory, and nearly every point has had to be worked out anew.

It has now been ascertained that a cold solution of mercuric nitrate shaken with mercury is at once and fully converted into one of mercurous nitrate, one of mercuric acetate into mercurous acetate, and one of mercuric chloride into simple water and a precipitate of mercurous chloride. As was better known, moist mercuric sulphate or phosphate quickly becomes all mercurous salt, with evolution of heat, when rubbed with mercury.

Mercurous nitrate in boiling water becomes mercuric nitrate and metallic mercury, which distils with the steam. Other mercurous

salts, soluble or insoluble, *e.g.*, the chloride, behave similarly. This dissociation proceeds also at lower temperatures, even to a measurable extent at 40° , in the case of the nitrate, on condition that, by a current of air, the mercury vapour is carried away.

Mercurous salts, in solution or moist, are also all dissociated at the common temperature by strong daylight, the acetate allowing the effects of dissociation to be very clearly observed.

Mercurous nitrate, when free from its mother liquor, is a stable salt, unchanged in the air, if not exposed to bright light. In solution in the dark, in a closed vessel, it is also stable even in an atmosphere of oxygen. There is no evidence that this or any other mercurous salt, whether in solution or only moist, is oxidisable in the air at common or only moderately elevated temperatures. What has been supposed to be the effect of oxidation, as in Mialhé's experiments, is the effect of dissociation. Mercurous oxide alone is oxidisable.

Mercurous salts, in presence of water, and best when in solution, oxidise in air or oxygen at a temperature of 150° . Thus, mercurous chloride can be largely, if not wholly, changed by oxidation into mercuric chloride in presence of hydrochloric acid. When mercurous chloride, boiled with hydrochloric acid under atmospheric pressure, becomes mercuric chloride, it does so by dissociation, not by appreciable oxidation.

Mercurous nitrate in water at the common temperature, but in strong daylight, becomes mercuric salt by reduction of its own nitric acid to nitrous acid. Exposure in an open vessel, or to an atmosphere of mercury vapour, or even to undiluted oxygen, retards the progress of the change by keeping down the quantity of nitrous acid which otherwise increases with time. An atmosphere of carbon dioxide favours, that is, does not impede, the change.

Mercurous nitrate also freely becomes mercuric nitrate and nitrite when kept in solution at 150° under pressure.

Mercurous oxide both oxidises and dissociates at the common temperature, as has been shown by Barfoed. Exposed to the air, it increases or lessens in weight, according to conditions. Shut up in an atmosphere of moist air, it gains in weight, dissociation being checked and oxidation favoured. Exposed with large surface to the open air, it loses in weight, for then dissociation and volatilisation of the mercury go on faster than oxidation of the undecomposed mercurous oxide.

134. "The effect of heat on aqueous solutions of chrome alum."

By Margaret D. Dougal.

As is well known, the colour of an aqueous solution of chrome alum, when heated, changes from violet or purple to green, and,

on evaporating, the green solution yields a green, non-crystalline mass.

The author has made a series of observations on the relative rates of diffusion of green and violet solutions of the same initial strength which go to prove that the green diffusate contains less chromium and more sulphuric acid than the violet diffusate, which is compatible with the assumption that the green solution contains a colloidal, and, therefore, slowly diffusing chromosulphuric acid. This conclusion is in harmony with the results recently arrived at by Monte, and inferred by Whitney, that when a solution of chrome alum is heated it is resolved into a mixture of potassium sulphate, chromylsulphuric acid and free sulphuric acid, according to the following equation:—

$$2[\text{Cr}_2(\text{SO}_4)_3 \cdot \text{K}_2\text{SO}_4] + \text{H}_2\text{O} = [\text{Cr}_2\text{O}(\text{SO}_4)_4]\text{SO}_4 + 2\text{K}_2\text{SO}_4 + \text{H}_2\text{SO}_4.$$

Experiments have also shown that solutions of chrome alum, after heating, are less dense than the unchanged or violet solutions, the expansion being due, in all probability, to the production of the free sulphuric acid.

135. "On the hydrolysis of ethylic dicarboxylglutaconate."

By H. W. Bolam, B.Sc., Ph.D.

It was found impossible to prepare glutaconic acid in quantity from ethylic dicarboxylglutaconate, following the directions of Conrad and Guthzeit (*Annalen*, 222, 254). Attempts to prepare this acid from β -oxyglutaric acid likewise failed. No oxyglutaric acid, such as v. Pechmann and Jenisch (*Ber.*, 1891, 24, 3250) describe, could be isolated from the product of the reduction of acetonedicarboxylic acid by means of sodium amalgam.

It was found that ethylic dicarboxylglutaconate underwent, on boiling with alkalis (baryta and caustic potash), a remarkable decomposition, the products being malonic acid and formic acid. The yields of glutaconic acid are still further reduced by the action of alkali, it being shown that oxyglutarates (possibly β -) are formed. The decomposition is effected on boiling with a one per cent. solution of baryta; in the cold, on the other hand, no such decomposition was observed with even a 20 per cent. solution of caustic potash. On saponifying the ethylic dicarboxylglutaconate with acids no such decomposition takes place; here, however, syrupy products, presumably both α - and β -oxyglutaric acids and the lactone acid, butyrolactone carboxylic acid, are formed, and these hinder the crystallisation of the glutaconic acid. Using 11 per cent. hydrochloric acid, and observing certain precautions in boiling, and on evaporation, yields of from 50 to 60 per cent. of glutaconic acid are got.

Ethylic benzyldicarboxylglutaconate undergoes no decomposition

on boiling with alkalis, nor does the benzylglutaconic acid thus formed show any tendency to form oxy-acids. It is supposed that other alkyl substituted ethylic dicarboxylglutaconates behave similarly, and it is suggested that an explanation of the decomposition of the simple ethylic dicarboxylglutaconate is to be found in the presence of the hydrogen atom replaceable by a metal, and that, further, only ethers having such a replaceable hydrogen atom may be expected to show an analogous decomposition on boiling with alkalis.

136. "The periodic law." By R. M. Deeley.

In this paper it is pointed out that the manner in which the elements group themselves varies according to the comparative importance which is attached to their several physical and chemical properties. The elements have generally been grouped in accordance with their most striking chemical properties. When thus grouped the author shows that many of them do not fall in with a regular periodic system, and the arrangement would seem to indicate that quite a number of elements of small atomic weight remain to be discovered. On the other hand, when they are grouped in accordance with the periodic changes in the values of many of their physical properties, the result is much more satisfactory. As an example, the refraction equivalents are instanced, helium being shown to fill a blank for a missing element (pointed out in a previous paper), whilst argon falls most naturally between sodium and fluorine. The periodic arrangement proposed makes the list of elements of smaller atomic weight than iodine complete, if we discount the possibility of the existence of a whole group of inert elements of lower atomic weights respectively than hydrogen and the alkali metals.

137. "The colouring matters occurring in various British plants."

Part I. By A. G. Perkin and J. J. Hummel.

Formerly numerous British plants were employed in dyeing, and at present in remote districts, notably the Highlands of Scotland, some are still used for this purpose. Many of these have been found sufficiently strong in colouring matter to warrant their chemical examination.

The colouring matters of the yellow wallflower, Cheiranthus cheiri.—An aqueous extract of the flowers when digested with acid deposits a precipitate of colouring matter; this was found to consist of two substances which could be separated readily, owing to the difference of their solubilities in alcohol. The *more soluble* product which was obtained as yellow needles, had the formula $C_{15}H_{10}O_7$, yielded an acetyl compound, $C_{15}H_5O_7(C_2H_3O)_5$; colourless needles, m. p. 189—191°;

when decomposed with fused alkali, protocathechuic acid and phloroglucin were produced. It was found to be *quercetin*.

The sparingly soluble colouring matter, $C_{16}H_{12}O_7$, minute, yellow needles, gave an acetyl compound, colourless needles, melting at $195-196^\circ$, and when acted upon by hydriodic acid, it yielded *quercetin*, and one molecule of methylic iodide. It was thus a *quercetin monomethyl ether*. Though closely resembling rhamnetin it is not identical with it, for acetylramnetin melts at $184-185^\circ$; and for it is proposed the name *isorhamnetin*.

The colouring matter in white hawthorn blossoms, *Crætagus oxyantha*, was obtained as yellow needles having the formula $C_{15}H_{10}O_7$. Its acetyl compound, colourless needles, melted at $189-191^\circ$, and when fused with alkali, phloroglucin and protocathechuic acid were formed. There could be no doubt as to its identity with *quercetin*. It is most probable that these colouring matters exist in the above plants as glucosides. This point will be studied at a later date.

133. "Position-isomerism and optical activity; the comparative rotatory powers of the dibenzoyl and ditoluyltartrates." By Percy Frankland, Ph.D., F.R.S., and Frederick Malcolm Wharton, A.I.C.

The authors have recently shown (Trans., 1896, 1309) that the rotatory effect of the para-toluyll radicle is greater than that of the meta- and this again greater than that of the ortho-toluyll group. This relationship, they have pointed out, is in harmony with the relative position of the centre of gravity in these several groups, for assuming that the centre of gravity of the benzene ring is the geometrical centre of a regular hexagon, it is obvious that in the ortho-arrangement of the toluyll group the centre of gravity is somewhat nearer, in the meta-arrangement somewhat further, and in the para-arrangement still further than that geometrical centre from the carbonyl carbon atom by means of which the ring is in each case attached to the asymmetric carbon atom of the tartaric acid. They have now investigated the relationship subsisting between the rotation of these toluyll compounds and the corresponding benzoyll derivatives. To this end they have studied the rotation, over a wide range of temperature, of methylic and ethylic dibenzoylltartrate, with the result that they have found that the rotation of the benzoyll compound is in each case intermediate between that of the corresponding ortho- and meta-toluyll derivative. This is also the relative position of the centre of gravity in the respective rings with regard to the carbonyl carbon atom by means of which they are attached.

Methylic and ethylic dibenzoylltartrates, like the corresponding ditoluylltartrates, were found to possess rotations which are very sensitive to temperature, the high negative value of the rotation

diminishing with rise of temperature. In this connection ethylic dibenzoyltartrate was found to exhibit the phenomenon of a maximum rotation. This maximum is situated in the vicinity of its melting point, the rotation values diminishing more and more as it is examined in a state of superfusion at temperatures further and further below its melting point.

139. "Researches on the terpenes. VII. Halogen derivatives of camphor." By J. E. Marsh and J. H. Gardner.

When camphor is treated with a mixture of bromine and phosphorus trichloride at the ordinary temperature, it yields a mixture of two isomeric compounds, of the formula $C_{10}H_{14}Br_4$, α - and β -tribromocamphene hydrobromides. The two compounds are separated by crystallising from light petroleum.

α -Tribromocamphene hydrobromide crystallises from chloroform in large colourless crystals; it melts at 168° , and its specific rotatory power $[\alpha]_D = +90.3^\circ$.

β -Tribromocamphene hydrobromide melts at 143 — 144° , and has the rotatory power $[\alpha]_D = +7.6^\circ$.

When boiled with sodium methylate in methyl alcohol both the above mentioned compounds react in the same way, losing hydrobromic acid, and yielding the same *tribromocamphene*, $C_{10}H_{13}Br_3$.

Tribromocamphene melts at 75 — 76° , and has the specific rotatory power $[\alpha]_D = +33.5^\circ$.

The action of bromine and phosphorus trichloride on other substances has been examined. Borneol yields the same compound (m. p. 168°) as camphor. Ordinary turpentine gives a new compound of the formula $C_{10}H_{14}Br_6$, which crystallises in colourless needles melting at 150° .

When pentachloride of phosphorus acts on camphor in the cold two isomeric chlorocamphene hydrochlorates are obtained, which may be separated by petroleum ether. One of these compounds, *α -chlorocamphene hydrochloride*, appears to be in all respects identical with that originally described by Spitzer, having the melting point 155° , and specific rotatory power $[\alpha]_D = -9^\circ$.

β -Chlorocamphene hydrochlorate is very slightly soluble in petroleum ether, and crystallises from the hot solution in large, colourless, hard crystals, that obtained by Spitzer forms small, soft, binding crystals. The new isomeride melts at 168° , and has the rotatory power $[\alpha]_D = -27.7^\circ$. When boiled with zinc dust and glacial acetic acid it yields *chlorocamphene*, $C_{10}H_{15}Cl$, a colourless solid of low melting point, which distils at 202° , and has a specific rotatory power $[\alpha]_D = -29.7^\circ$.

Spitzer's compound also yields a chlorocamphene by the same treatment, but it is difficult to say whether it is identical with or different from the derivative of the β -compound. It is usually contaminated with higher chlorinated products.

When chlorocamphene is acted on with strong sulphuric acid it dissolves, with evolution of hydrogen chloride, and on pouring the solution into water a liquid is obtained, which can be distilled in steam. It has a strong camphorous smell, and burning taste. It boils at 230° , and has the composition $C_{10}H_{16}O$. The examination of its properties is not completed, but it appears to be a saturated tertiary alcohol, and is probably a hydroxyl derivative of camphene.

140. "Derivatives of camphenesulphonic acids." By Arthur Lapworth, D.Sc., and Frederic Stanley Kipping, Ph.D., D.Sc.

This paper contains an account of the study of the two camphenesulphonic chlorides which are obtained as bye-products in the preparation of camphorsulphonic chloride; the properties of these substances, and those of all their more important derivatives, have been briefly described in previous notes (Proc., 1895, 57; 1896, 152).

141. "Preparation of dimethylketohexamethylene and experiments on the synthesis of dimethylhexamethenylmalonic acid." By F. Stanley Kipping, Ph.D., D.Sc., and W. B. Edwards.

The appearance of a paper by Verwey on "Pentamethenylmalonic acid and Pentamethenylacetic acid," in a recent number of the *Berichte* (29, 1996) has led us to take the earliest opportunity of making known the results of some experiments which were commenced last spring, and which were undertaken, partly with the object of synthesising dimethylhexamethenylmalonic acid and dimethylhexamethenylacetic acid—homologues respectively of the compounds described by Verwey—and partly with the object of making a general study of hexamethylene derivatives.

To obtain these substances it was necessary to prepare dimethylketohexamethylene (Trans., 1895, 349) and for this purpose a large quantity of dimethylpimelic acid was required; in the first place, therefore, we endeavoured to find a better method for preparing this acid than the one previously adopted (Trans., 1891, 569), and this we accomplished in the following manner:—The acetyldimethylcaproic acid which is formed, together with dimethylpimelic acid, by the hydrolysis of ethylic dimethyldiacetylpmelate (*loc. cit.*), is dissolved in excess of aqueous sodium hydroxide and bromine is then added, in small quantities at a time, until bromoform is no longer produced; under these conditions the acetyldimethylcaproic acid seems to be converted quantitatively into dimethylpimelic acid.

This fact being established, the crude mixture of acids directly obtained from ethylic dimethyldiacetylpinelate may be submitted to oxidation in the above manner, the troublesome separation of the two acids thus being avoided.

Having prepared a considerable quantity of dimethylpinelic acid in this way, we converted it into dimethylketohexamethylene by distilling its barium salt and reduced the ketone with sodium in moist ethereal solution, thus obtaining the corresponding alcohol, which has been recently described by Zelinsky; this alcohol was then converted into dimethylhexamethylene bromide by treating it with hydrobromic acid.

We then began to study the conditions under which ethylic dimethylhexamethenylmalonate could be prepared by the interaction of dimethylhexamethylene bromide and ethylic sodiomalonate, but the experiments were interrupted by the summer vacation, and have not yet been resumed; as, however, they will be continued at an early date the publication of this note seemed desirable.

The fact that Noyes (*Ber.*, 1896, 2326) has lately obtained from dihydrocampholytic acid (*cis*) a ketone which may be identical with dimethylketohexamethylene, enhances the interest which is attached to the further study of this compound.

142. "Sulphocamphylic acid ($C_8H_{11}SO_3$), with remarks on the constitution of camphoric acid and of camphoronic acid." By William Henry Perkin, jun.

In two previous notices (*Proc.*, 1893, 109; 1895, 23), the author stated that when sulphocamphylic acid is fused with potash, the principal products of the reaction are two isomeric acids, $C_8H_{12}O_2$ (or $C_8H_{11}\cdot COOH$), for which he proposes the names α -camphylic acid and β -camphylic acid; the former melts at 148° , the latter at about 105° .

Besides these two acids, it has since been found that $\alpha\alpha$ -dimethylsuccinic acid, $COOH\cdot C(CH_3)_2\cdot CH_2\cdot COOH$, and small quantities of dicamphylic acid, $C_{16}H_{22}(COOH)_2$ (m. p. 225°) are formed during the fusion. The latter acid, which has not been very fully investigated, is decomposed on distillation, with formation of α -camphylic acid.

α -Camphylic acid (m. p. 148°) is readily acted on by phosphorus trichloride, with formation of α -camphylic chloride, $C_8H_{11}COCl$ (b. p. about 133 — 140° at 60 mm., with decomposition). The anilide, $C_8H_{11}CONHC_6H_5$, melts at 111° , and the ethylic salt, $C_8H_{11}COOC_2H_5$, is a colourless oil, which distils at 132° (70 mm.).

All these derivatives yield α -camphylic acid again on hydrolysis, and not an isomeric acid (see below under β -camphylic acid).

α -Camphylic acid dibromide, $C_8H_{11}Br_2\cdot COOH$, is formed when bromine is added to the solution of α -camphylic acid in chloroform;

it melts at 157° , and when digested with glacial acetic acid, it is converted into *bromo- α -camphylic acid*, $C_8H_{10}Br\cdot COOH$ (m. p. 107°), with elimination of hydrogen bromide.

α -Camphylic acid dihydrobromide, $C_8H_{13}Br_2\cdot COOH$, is produced by dissolving α -camphylic acid in a saturated solution of hydrogen bromide in glacial acetic acid. It melts at 156 — 157° , and when boiled with water or digested with quinoline it is reconverted into α -camphylic acid.

On reduction with sodium amalgam, α -camphylic acid yields *dihydro- α -camphylic acid*, $C_8H_{13}\cdot COOH$, a colourless oil, which distils at 165 — 170° (50 mm.); it is an unsaturated acid, and possibly identical with the dihydro acid obtained from β -camphylic acid by reduction (see below). When oxidised with potassium permanganate, α -camphylic acid is converted into a new monobasic acid of the formula $C_8H_{13}O_3\cdot COOH$ (m. p. 148°), and this acid, on oxidation with chromic acid, is decomposed, with formation of acetone, acetic acid, and other products which are at present under investigation.

β -Camphylic acid, $C_8H_{11}\cdot COOH$ (m. p. 105°), combines readily with bromine yielding *β -camphylic acid dibromide*, $C_8H_{11}Br_2COOH$ (m. p. about 177°), and this acid, when heated with glacial acetic acid, loses 1 mol. of hydrogen bromide with formation of *bromo- β -camphylic acid*, $C_8H_{10}Br\cdot (COOH$ (m. p. 150°), in which the bromine atom is so firmly bound that the acid may be boiled with strong potash, or with zinc dust and acetic acid, for some time without decomposition. When digested with quinoline, there is no elimination of hydrogen bromide, but the acid is converted into $C_8H_{10}Br\cdot COOH$, *isobromo- β -camphylic acid* (m. p. 168°); probably these two bromo- β -camphylic acids are stereoisomeric.

β -Camphylic acid hydrobromide, $C_8H_{12}Br\cdot COOH$, is produced when β -camphylic acid is dissolved in a fuming solution of hydrogen bromide in glacial acetic acid. It melts at 138 — 140° , and, when boiled with water or digested with quinoline, is reconverted into β -camphylic acid.

When treated with sodium amalgam, β -camphylic acid yields an oily reduction product, $C_8H_{13}\cdot COOH$, which boils constantly at 190° (80 mm.); this oil is probably a mixture of isomeric *dihydrocamphylic acids*, as, under certain conditions, it deposits crystals of a dihydrocamphylic acid which melts at 130° .

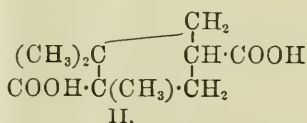
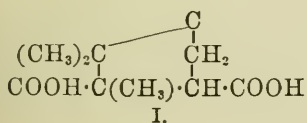
Iso- β -camphylic acid, $C_8H_{11}COOH$, is formed when β -camphylic acid is digested with phosphorous trichloride and the product, after fractionation, decomposed with water. It melts at 130° , and is probably stereoisomeric with β -camphylic acid; the *chloride*, $C_8H_{11}COCl$, distils with very little decomposition at 135° (60 mm.); the *ethylic salt*, $C_8H_{11}COOC_2H_5$, is a colourless oil which boils at 140° (60 mm.),

and the *anilide*, $C_8H_{11}CONHC_6H_5$, crystallises in colourless needles and melts at 103° .

When oxidised, first with potassium permanganate and then with chromic acid, β -camphylic acid yields *αα*-dimethylsuccinic acid, $COOH \cdot C(CH_3)_2 \cdot CH_2 \cdot COOH$ (m. p. 140°), *αα*-dimethylglutaric acid, $COOH \cdot C(CH_3)_2 \cdot CH_2 \cdot CH_2 \cdot COOH$, and a *ketonic acid*, $C_8H_{11}O_3$, which melts at about 50 – 51° .

This latter acid gives a beautifully crystalline *semicarbazone* $C_9H_{17}N_3O_3$ (m. p. 187°); on oxidation with nitric acid, it yields *αα*-dimethylsuccinic acid, and, when treated with bromine and potash, it is decomposed, with formation of tetrabromomethane and *αα*-dimethylglutaric acid; it is therefore exceedingly probable that it is of the formula $CH_3 \cdot CO \cdot C(CH_3)_2 \cdot CH_2 \cdot CH_2 \cdot COOH$, an *acetyldimethylbutyric acid*, and very likely identical with an acid, $C_9H_{11}O_3$, which Tiemann (*Ber.*, 1895, **28**, 2176) obtained by the oxidation of *β*-*dihydroxydihydrocampholenic acid* with chromic acid, and to which he assigns the constitution given above.

The various decompositions of α - and β -camphylic acids, briefly stated above, as well as the results of a number of further experiments, which the author hopes soon to be able to communicate to the Society, throw much light on the constitution of these acids, as well as on the constitution of sulphocamphylic acid, and indirectly on that of camphoric acid. In this short abstract it is, of course, not possible to enter into this matter in detail, but it may be stated that it is exceedingly difficult to account for the observed behaviour of these substances on the assumption that the formulæ either of Bredt or of Tiemann for camphoric acid are correct. If, however, camphoric acid has the constitution represented by either of the following formulæ:



(of which the author considers formula I the more probable), then not only the formation of acetyldimethylbutyric acid from sulphocamphylic acid, but also the various decompositions of the camphylic acids may be readily understood, and the author has further satisfied himself that all the other reactions of camphoric acid are at least as readily, and, in most cases much more easily, explained with the help of these formulæ than with that of any other formulæ which have, so far, been suggested. The author hopes that the discussion of these new formulæ will be reserved until he has been able to explain their

application in the detailed description of the experimental results indicated above.

Camphoronic acid.—Bredt has assigned to this acid the formula $\text{COOH} \cdot \text{CH}_2 \cdot \text{C}(\text{CH}_3)_2(\text{COOH}) \cdot \text{CH}_2 \cdot \text{COOH}$, and it seems very probable that this expression (which also follows from the formulæ I and II given above) is the correct one.

Tiemann (*Ber.*, 1895, 28, 1089), on the other hand, represents camphoronic acid as $\text{COOH} \cdot \text{CH}(\text{CH}_3) \cdot \text{C}(\text{CH}_3)_2 \cdot \text{CH}(\text{COOH})_2$, and when the paper putting forward this view appeared, the author privately suggested to Professor Tiemann that this expression could hardly be correct, since the acid, on heating, does not lose carbon dioxide, forming a corresponding dibasic acid, as would be the case if, as represented, the acid were a derivative of malonic acid.

Tiemann (*Ber.*, 1895, 28, 2163) replied to this that the acid did not decompose in this way, because it first loses water, and yields

anhydrocamphoronic acid, $\begin{array}{c} \text{CH}(\text{CH}_3) \cdot \text{C}(\text{CH}_3)_2 \cdot \text{CH} \cdot \text{COOH} \\ \text{CO} \text{ — } \text{O} \text{ — } \text{CO} \end{array}$, which he

considers would be stable at high temperatures. But an acid of this

formula is similarly constituted to $\begin{array}{c} \text{CH}_2 \cdot \text{CH}_2 \cdot \text{CH} \cdot \text{COOH} \\ \text{O} \text{ — } \text{CO} \end{array}$, carbobutyro-

lactonic acid, which, at 120° , very readily decomposes, with elimination of carbon dioxide and formation of butyrolactone.

In contact with water, anhydrocamphoronic acid is at once converted into camphoronic acid, and it appeared to the author that the validity of Tiemann's formula might be tested by heating an aqueous solution of camphoronic acid at high temperatures. The result of experiments on this point showed that camphoronic acid is not appreciably decomposed when heated with water in sealed tubes at $225\text{--}235^\circ$ for two hours, a result which appears to the author to prove conclusively that Tiemann's formula cannot be correct.

In confirmation of this it may be mentioned that Bredt (*Annalen*, 292, 131) has lately shown that the triethylic salt of camphoronic acid, which according to Tiemann should contain the group $-\text{CH}(\text{COOC}_2\text{H}_5)_2$, does not react with sodium.

143. "On Pettenkofer's method for determining carbonic anhydride in air." By Professor Letts, D.Sc., Ph D., and R. F. Blake, F.I.C.

The authors discuss the errors in the process of absorbing the carbonic anhydride from a sample of air collected in a glass vessel by baryta, and titrating with acid, and show that, in addition to the more obvious sources of error, the action of the alkaline absorbent on the glass is one of importance.

In order to avoid it they coat both the receiver containing the air

sample and the bottle holding the stock of standard solution of baryta with paraffin wax. By this means they at once obtained more concordant results in a series of determinations. They then proceeded to test the degree, both of accuracy and of delicacy, of Pettenkofer's process if carried out with all the available precautions which suggested themselves. For this purpose they employed paraffined receiving vessels, an apparatus for performing the titrations in a vacuum, and burettes of special construction. In addition, an apparatus was used for delivering, very accurately, measured volumes of pure carbonic anhydride into known volumes of air previously freed from that gas.

Experimenting with such mixtures of the two as occur in air, containing about 3 vols. carbonic anhydride in 10,000, the authors show that with careful work the mean error in the determinations need not exceed -0.04 part. The actual quantity of carbonic anhydride added to each receiver full of air, in a series of five experiments, amounted to 0.927 c.c.; the mean amount, found to be 0.916 c.c., giving, therefore, a mean error of -0.011 c.c.

They thus show that Pettenkofer's process, if suitably performed, is one of great accuracy and delicacy.

After giving the results of a series of determinations of carbonic anhydride in ordinary air, the authors comment on the method described by Messrs. Symons and Stephens (Trans., 1896, 869) for such determinations and some of the results obtained by them. Sources of error in the process are pointed out, especially the introduction of small quantities of carbonic anhydride with the steam used to render the receiving vessels vacuous. In support of this contention they draw attention to an experiment described by Messrs. Symons and Stephens in which 0.2 c.c. of carbonic anhydride were thus found in a flask of 3 litres capacity, an amount corresponding with nearly 0.67 volumes in 10,000 supposing the flask to have been filled with air, which is nearly one-fifth the total quantity usually found in "fresh" air.

Although aware of the error thus introduced, Messrs. Symons and Stephens do not (as far as the authors can judge from their paper) make any correction for it in their subsequent determinations.

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Flügge, Dr. C. Die Mikroorganismen. Mit besonderer Berücksichtigung der Ätiologie der Infektionskrankheiten. Dritte, völlig umgearbeitete Auflage. Erster Theil. xvi+596 pp. Mit 57 Abbildungen im Text. Zweiter Theil. xxii+751 pp. Mit 153 Abbildungen im Text. Leipzig 1896.

Gattermann, Ludwig. The Practical Methods of Organic Chemistry. Translated by William B. Shober. With numerous illustrations. xi+330 pp. New York 1896. 8vo.

Helmholtz, H. v. Zwei Hydrodynamische Abhandlungen. Herausgegeben von A. Wangerin. 79 pp. Leipzig 1896.

(Ostwald's Klassiker der Exakten Wissenschaften. No. 79.)

Kalman Wilhelm. Kurze Anleitung zur Chemischen Untersuchung von Rohstoffen und Produkten der landwirtschaftlichen Gewerbe und der Fettindustrie. x+133 pp. Mit 3 Abbildungen im Text. Leipzig und Wien 1896.

Kohlrausch, F. Leitfaden der Praktischen Physik mit einem Anhang des absolute Mass-system. Mit in den Text gedruckten Figuren. Achte vermehrte Auflage. xxiv+492 pp. Leipzig 1896.

Ohlmüller, W. Die Untersuchung des Wassers. Mit 75 Textabbildungen und einer Lichtdrucktafel. Zweite durchgesehene Auflage. xi+178 pp. 8vo. Berlin 1896.

Scoffern, John. Chemistry no Mystery; or a Lecturer's Bequest. Arranged from the Original Manuscript, and revised by. vii+310 pp. London 1839.

Thomson, Thomas. The History of Chemistry. Second edition. 2 vols. in one. vii+349+325 pp. London.

Windisch, Karl. Die chemische Untersuchung und Beurtheilung des Weines. Mit 33 in den text gedruckten Figuren. xix+351 pp. Berlin 1896.

II. *Donations.*

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From the Author.

Aikin, Arthur. A Manual of Mineralogy. Second edition, with additions and corrections. viii+263 pp. London 1815.

From S. G. Rosenblum, Esq.

Allen, Alfred H. *Commercial Organic Analysis*. Vol. III, Part III. xii+508. London 1896. From the Author.

Brande, W. T. *A Manual of Chemistry, containing the principal facts of the Science, arranged in the order in which they are discussed and illustrated in the lectures at the Royal Institution of Great Britain*. xlvii+652 pp. London 1819.

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From the Authors.

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From the Authors.

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Dey Kanny Lall. *The Indigenous Drugs of India*. Second edition. xxxviii+387 pp. Calcutta 1896.

From the Author.

Evans, J. Castell. *A New Course of Experimental Chemistry, including the Principles of Qualitative and Quantitative Analysis*. Third edition. xi+244 pp.

From the Publishers.

Fresenius, Dr. C. Remigius. *A System of Instruction in Quantitative Analysis*. Second edition. Edited by J. Lloyd Bullock, F.C.S. xvi+624 pp. London 1854.

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From the Translator.

Kidd, J. Outlines of Mineralogy. Vol. I. ix+255 pp.; Vol. II. viii+227. Appendix 39 pp. London 1809.

From S. G. Rosenblum, Esq.

Lavoisier. Elements of Chemistry in a new systematic order containing all the modern discoveries, illustrated by thirteen copper plates. Translated from the French by Robert Kerr. 4th edition. xxxvi+592 pp. Edinburgh 1799.

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Liebig, Justus. Organic Chemistry in its application to Agriculture and Physiology. Edited from the manuscript of the author by Lyon Playfair, Ph.D. xvi+387 pp. London 1840.

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Liebig, Justus. Animal Chemistry or Organic Chemistry in its applications to Physiology and Pathology. Edited from the author's manuscript by William Gregory, M.D. xix+354 pp. London 1842.

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Liebig, Justus. Lettres sur le Chimie et sur ses applications à l'Industrie, à la Physiologie et à l'Agriculture. Traduites de l'Allemand par le Dr. G. W. Bichon. xi+331 pp. Paris 1845.

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Liebig, Justus. Nouvelles Lettres sur la Chimie, considérée dans ses applications à l'Industrie, à la Physiologie et à l'Agriculture. Édition Française publiée par Charles Gerhardt. xii+330 pp. Paris 1852.

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From the Author.

Thorpe, T. E. Humphrey Davy, Poet and Philosopher. vii+240 pp. London 1896.

From the Author.

Tollens, B. Les Hydrates de Carbone. Traduit de l'Allemand par Léon Bourgeois. vi+770 pp. Avec 24 figures dans le texte. Paris 1896.

From the Publishers.

Whytt, Robert. An Essay on the Vital and Involuntary Motions of Animals. x+392 pp. Edinburgh 1751.

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“The nitrites of mercury and the conditions under which they are formed.” By P. C. Rây, D.Sc.

“The interaction of mercurous nitrite and the alkyl iodides.” By P. C. Rây, D.Sc.

“Crystallography of the monohydrated mercurous nitrite.” By T. H. Holland.

“Sulphocamphoric acid and other derivatives of camphorsulphonic acid.” By A. Lapworth, D.Sc., and F. S. Kipping, Ph.D., D.Sc.

“Solution and diffusion of certain metals and alloys in mercury. Part II.” By W. J. Humphreys.

“Note on the heat of formation of the silver amalgam, Ag_2Hg_8 .” By Fannie I. Littleton.

“On the identity of dextrose from different sources with special reference to the copper oxide reducing power.” By C. O’Sullivan, F.R.S., and A. L. Stern, D.Sc.

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- Annuaire de l'Académie Royale des Sciences, des Lettres et des Beaux-Arts de Belgique.
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 ——— Proceedings.
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 Physikalisch-Technische Reichsanstalt, Berlin. Wissenschaftliche Abhandlungen.
 Quarterly Journal of Microscopical Science.
 Recueil des Travaux Chimiques des Pays-Bas.
 Repertorium der Technischen Journal-Litteratur. Berlin.

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- Vierteljahresschrift der Chemie der Nahrungs und Genussmittel.
- Vierteljahresschrift der Naturforschenden Gesellschaft in Zürich.
- Year-Book of Pharmacy, and Transactions of the British Pharmaceutical Conference.
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CERTIFICATES OF CANDIDATES FOR ELECTION AT THE NEXT BALLOT.

N.B.—The names of those who sign from “General Knowledge” are printed in *italics*.

The following Candidates will be balloted for on Thursday, December 3, 1896:—

Aykroyd, Henry Edward,

Ashwell, Tollen Lane, Bradford.

One of Principals of Wm. Aykroyd & Sons, Oakwood Dye Works. Director of the Chemical and Technical Investigations at the Dye Works. Seven years private Student in F. W. Richardson's Analytical Laboratory. Honours Organic Chemistry, Science and Art, 1892. Conjoint author of recent original papers on “Sulphites, Sulphates, &c.”, “Cachou de Laval” (J.S.C.I.). Member of Committee Yorks. Sec., S.C.I.

F. W. Richardson.

G. W. Slatter.

Henry R. Procter.

Arthur Smithells.

J. J. Hummel.

C. Rawson.

Ballingall, William.

“Ardarroch,” Dundee.

Manager of Messrs. Ballingall & Son, Brewers, Dundee. Studied at University College, Dundee, under the late Dr. Carnelley, and Dr. Percy Frankland, F.R.S.; also the Chemistry of Brewing, under Mr. Lawrence Briant, F.C.S. F.R.M.S., Mem. Soc. Pub. Anal., Master of Arts, St. Andrew's University. Analytical Chemist of Park and Pleasance Breweries, Dundee, for past six years.

William Frew.

Andrew Thomson.

James R. Appleyard.

Lawrence Briant.

Arthur J. Starey.

John Foggie.

Frank W. Young.

Bathurst, Charles, jun.

Lydney Park, Gloucestershire.

B.A. (Oxon), Barrister-at-Law, &c., &c. Gold Medallist and

Member of the Royal Agricultural College (by examination). Silver Medallist and Life Member of the Royal Agricultural Society (by examination).

Edward Kinch.

Cecil Cooke Duncan.

J. Augustus Voelcker.

J. Henry Gilbert.

A. H. Church.

George Embrey.

T. A. Dickson.

Bay, Lauritz Hansen.

The Grammar School, Carlisle.

Science Master at Carlisle Grammar School. Studied under Mr. John Howard, 1888-1889, and later under Professor Tilden, at the Royal College of Science, S.W. Formerly Science Master and Lecturer in Chemistry under the Essex County Council, at Palmer's School, Grays. Have also lectured in Chemistry under the Derbyshire County Council at Wirksworth and Matlock, while Science Master at Wirksworth Grammar School. At present attempting Research Work in private laboratory.

William A. Tilden.

W. Palmer Wynne.

Chapman Jones.

Arnold Eiloart.

H. H. Slater.

Browne, Charles Edward.

2, Hinton Villas, Cheltenham.

Science Master, the Training College, Cheltenham. Graduate in Science (London). 1st Class Honours, Practical Chemistry, Science and Art Department. Science Master and head of Chemical Department.

B. S. Gott, M.A. (Cantab.).

A. E. Tutton.

Frank Gossling.

R. Meldola.

Robt. G. Grimwood.

Cobb, Walter William,

Hilton House, Atherstone.

Assistant Schoolmaster. M.A., Oxon, Science Master of the Atherstone Grammar School. Late Junior Student of Christ Church, Oxford. Honours in Final School of Natural Science, Oxford, 1879. Registered Teacher of Science, under the Science and Art Department, South Kensington. Since 1879, the pupils of the candidate have gained about 200 certificates, chiefly in Chemistry, from the South Kensington Department. A private pupil is now a Professor at the Royal College of Science, London; another won 2nd Prize from the Warwick County Council in Chemistry in 1893. Other private pupils have won eight medals, including two gold ones for Chemistry,

from the Royal (Dick) Veterinary College, Edinburgh. Candidate is now Lecturer on Chemistry to the Warwick County Council.

A. Vernon Harcourt.

Harold B. Dixon.

T. C. Sharrott.

W. W. Fisher.

John Conroy.

V. H. Veley.

Cross, George Harold, B.Sc.,

Balliol College, Oxford.

Selected candidate in the Indian Civil Service. Three years in the Chemical Laboratories, Owens College, Manchester. B.Sc., with 1st Class Honours, in the Honours School of Chemistry, Victoria University. University Scholar in Chemistry, 1893.

H. B. Dixon.

G. H. Bailey.

W. H. Perkin, jun.

A. Harden.

P. J. Hartog.

Duncan, William,

Edinburgh.

Pharmaceutical Chemist and Teacher of Chemistry and Pharmacy. The candidate has been for 10 years Lecturer in Chemistry to pharmaceutical students, and in *Materia Medica* to medical students, at the Royal Dispensary, Edinburgh; this course in the latter is accepted by the University Court. He has also conducted numerous investigations in Pharmaceutical Chemistry, particularly in regard to alkaloids, the results of which have from time to time been published in the *Pharmaceutical Journal*.

M. Carteighe.

Thomas Tyrer.

Alex. Crum Brown.

John Attfield.

Alex. Gunn.

Peter MacEwan.

Leonard Dobbin.

Wyndham R. Dunstan.

H. Helbing.

Fred. W. Fletcher.

Elliott, Walter John,

5, Dover Place, Clifton, Bristol.

Schoolmaster. M.A. Cambridge. Senior Science Master in the Grammar School, Bristol.

Sydney Young.

Arthur Richardson.

Thomas H. Easterfield.

W. J. Sell.

H. J. H. Fenton.

Fleet, John Thomas,

Rugby, Warwickshire.

Analyst. Examination of Seaweeds, &c., for Iodine. Examination of Blue Clays for Alumina and Iron. Chemical Toxicology. General

Analyst in Rugby. Student at Wolsingham Grammar School. Technical College and Rutherford's College, Newcastle-on-Tyne.

Leopold M. Deane.

W. F. Wyley.

H. W. Jones.

Bernard E. Smith.

Watson Smith.

T. H. Dodd.

G. Stallard.

George, George,

Regent Street, Kingswood, near Bristol.

Assistant Master, Merchant Venturers' Technical College, Bristol. Inter. B.Sc. (Lond.). Second Class Honours in Physics. A.I.C. by Examination (January, 1896). Studied Chemistry at Merchant Venturers' Technical College, Bristol, since September, 1889, under T. Coomber, Dr. Cook, H. J. Palmer, Dr. Tingle, Dr. Leicester, Professor Wertheimer, and G. P. Darnell-Smith. Have done a good deal of commercial work in Analytical Chemistry. Am taking Final B.Sc. Examination (Lond.) in October next.

J. Wertheimer.

G. P. Darnell-Smith.

James Leicester.

Ernest H. Cook.

J. Bishop Tingle.

Hill, Arthur Croft,

Trinity College, Cambridge.

B.A. (Cantab.); 1st class Natural Science Tripos, Parts I and II (special subjects, Physiology and Chemistry). At present engaged in research in Physiological Chemistry.

James Dewar.

W. J. Sell.

H. J. H. Fenton.

Alexander Scott.

A. Sheridan Lea.

Hill, Charles Alexander,

Hawthorns, South Road, Clapham Park.

Manufacturing Chemist. Studied at the school of the Pharmaceutical Society; worked at the Chemical Laboratory, St. Thomas' Hospital, for one year; and for one year in the Research Laboratory of the Pharmaceutical Society. Subsequently has been engaged in research work. Associate of the Institute of Chemistry.

Wyndham R. Dunstan.

Percy F. Frankland.

Herbert McLeod.

Otto Hehner.

Francis H. Carr.

Hinchley, John William,

Baggeholme Road, Lincoln.

Metallurgist. Associate of Royal School of Mines (1st class). National Scholar (1893). Whitworth Exhibition (1894) and Scholar (1896). 4—5 years in Laboratory at Lincoln School of Science

and Royal College of Science. Honours 1st class, Practical and Theoretical (2nd in Chemistry, 1st in Metallurgy) Chemistry and Theoretical and Practical Metallurgy, Science and Art Department.

W. C. Roberts Austen.

William A. Tilden.

John Hope Belcher.

W. Palmer Wynne.

M. O. Forster.

J. S. S. Brame.

Lawrence, William Trevor,

57, Prince's Gate, London, S.W.

Private research. B.A., Oxford, Honour Schools, 1893. Ph.D. Berlin, 1896. Three years with Prof. Emil Fischer. Now in Prof. Perkins' Laboratory, Manchester. Published work, *Die Verbindungen der Zuckerarten mit Mercaptanen*, Berlin, 1896.

Henry E. Roscoe.

E. Frankland.

F. A. Abel.

M. Holzmann.

W. Palmer Wynne.

Littlefield, Robert Dexter,

23, Wightman Road, Harringay, N.

Student of Chemistry. During the last three years have been studying Chemistry and Physics at University College, Gower Street. Now Demonstrator in Chemistry in the Laboratory of the Pharmaceutical Society.

William Ramsay.

J. Norman Collie.

Morris W. Travers.

John Shields.

Edward C. Cyril Baly.

Arthur Lapworth.

W. A. H. Naylor.

Lloyd, Thomas Henry,

Penygraig, Pontiprid.

Analytical Chemist. I have been engaged at the Dowlais Iron Company's laboratory for 3 years, and at Dr. Dykes' Public Health Laboratory for one year; as Chemist to the Pottsville Iron Company one year, and have worked for 2 years at University College, Cardiff.

Claude M. Thompson, M.A.,

R. W. Atkinson.

D.Sc., F.C.S.

Robt. H. Owen.

A. A. Read.

E. P. Perman.

Thomas Hughes.

Lockwood, Thomas William,

Heckmondwike.

Science Teacher. Studied Chemistry at the Dewsbury Technical School, the Royal College of Science, and the Yorkshire College. Studied Experimental and Chemical Physiology at the Leeds Medical School. Obtained First Class Honours Inorganic and Honours

Organic Chemistry, Science and Art Department, South Kensington.
Teacher of Chemistry at the Batley and Liversedge Technical
Schools. Science Teacher to the Heckmondwike School Board.

Arthur Smithells.	Henry R. Procter.
I. Patchett.	Julius B. Cohen.
Thos. Ewan.	Herbert Ingle.
F. W. Branson.	J. Willis Marshall.
William A. Tilden.	Chapman Jones.
<i>Alfred H. Allen.</i>	<i>Martin O. Forster.</i>

G. S. Newth.

Manners, Hugh,

Academy House, Airdrie.

Rector, Airdrie Academy. Principal of Airdrie Science and Art
School, Teacher of Chemistry, Airdrie Academy, and formerly one
of the Science Masters, High School, Glasgow. M.A., B.Sc. (Glas.
Univ.). First Class Honours, Practical Organic and Inorganic
Chemistry, Science and Art Department.

John Ferguson.	A. Humboldt Sexton.
J. T. Bottomley.	Horatio Ballantyne.
G. G. Henderson.	<i>James J. Dobbie.</i>
<i>Edw. C. Stanford.</i>	<i>James McCutcheon.</i>

Geo. Ritchie.

Marks, Edward Seaborn,

Astwood House, 111, Cromwell Road, S.W.

Metallurgical Chemist. Have studied Chemistry (Theoretical and
Practical) at the Royal School of Mines under Professor Thorpe;
Physics under Professor Rücker, and Metallurgy under Professor
Roberts-Austen, and am an Associate, in Metallurgy, of the Royal
School of Mines.

T. E. Thorpe.	W. Palmer Wynne.
Henry C. Jenkins.	Ernest A. Smith.
Philip Schidrowitz.	Otto Rosenheim.

Mayfield, Arthur Stanley,

Avenue House, Beverley Road, Hull.

Analyst with Messrs. S. Tudor & Co., Lead Works, Hull. Have
passed Honours Practical Advanced Theory Inorganic. Analyst
with Messrs. S. Tudor & Co., Hull. Have studied at the Royal
Institution, Hull, under Mr. G. Carr Robinson, F.R.S.E., F.I.C.,
F.C.S., and done general Analytical work. Have made investiga-
tions in the manufacture and composition of White Lead, &c.

G. Carr Robinson.	Allan T. Hall.
Fred. E. Johnson.	H. Irving Foster.
<i>John Pattinson.</i>	<i>J. Carter Bell.</i>

C. C. Graham.

Miller, William M.,

Prye Estate, Wellesley Province, Penang, Straits Settlements.
 Chemist. Diploma and Gold Medal of the College of Science and Arts, Glasgow, 1884. Author of paper on Rum Manufacture. "Themerì," Improvements in Rum and Sugar Manufacture (Colonial).

James Napier. John S. MacArthur. John Clark.
 R. R. Tatlock. *Horatio Ballantyne.*

Moore, Landon Clarence,

19, Mecklenburgh Square, W.C.,
 Student of Chemistry. Educated at University College School. Have been studying Chemistry for four years at the Birkbeck Institute, and am desirous of devoting myself ultimately to Chemical Research. Particularly wish to receive the Society's Journal. Undergraduate of London University.

J. Woodward. F. Gossling. E. G. Clayton.
 Temple Orme. *Henry Bradford.* *J. Kear Colwell.*

Moss, Francis Ambrose,

Menzies, Western Australia.
 Assayer and Consulting Metallurgist. Certificated Assayer and Metallurgist. Four years chief Chemist B. H. P. Co.'s Refinery. Present engaged in private practice as Assayer and Consulting Metallurgist.

W. T. Gronow. James C. Fraser.
 L. R. Scammell. T. J. Greenway.
T. C. Cloud.

Moss, Herbert William,

Broken Hill Proprietary Co., Ltd., Port Pirie, South Australia.
 Metallurgist. Certificated Assayer and Metallurgist and Mine Surveyor. Five years Chemist and Assayer to the B. H. P. Co., Ltd. Present Assistant Superintendent B. H. P. Co., Ltd.

W. T. Gronow. T. C. Cloud.
 James C. Fraser. L. R. Scammell.
T. J. Greenway.

Mothe, Joseph Terrence de la,

Grand Bacolet Estate, St. Andrew's Parish, Grenada, West Indies.
 Agricultural Consulting and Analytical Chemist. Diploma in Agriculture of the Cambridge University. 1st Class Certificate of the Royal Agricultural Society of England. Diploma and Membership of the Highland and Agricultural Society of Scotland. Student

for over 3 years at Agricultural College, Aspatria. Pupil in Analytical work under Prof. Lloyd since January, 1895.

Fredk. J. Lloyd.

J. Augustus Voelcker.

Alexander Cameron.

R. Bodmer.

John M. Thomson.

Herbert Jackson.

Muter, Alexander Henry Mitchell,

The Châtelet, Horley, Surrey.

Analytical Chemist. Three years course in King's College under Professor Thomson. Subsequently passed the Examination as Associate of the Institute of Chemistry, and now employed at the South London Public Laboratory.

John M. Thomson.

John Muter.

Herbert Jackson.

Bernard Dyer.

Leonard de Koningh.

Pearsall, William Harrison,

The School House, Dalton-in-Furness.

Principal of the Higher Grade School, Dalton-in-Furness. Smith Memorial Scholarship for Advanced Theoretical and Practical Chemistry, Council Prize and 4 Queen's Prizes (Science and Art Dept.), Birmingham, 1884. Lecturer in Chemistry, Birmingham School Board. For years engaged in teaching the subject in the school laboratories, and also for the Technical Board under Science and Art Dept. here and at Stourbridge.

Arthur Adams.

Horace W. Crowther.

Alfred R. Gower.

Charles Bayliss.

Arthur Hadley.

Thos. W. Berry.

F. W. Westaway.

W. J. Lancaster.

H. S. Shorthouse.

William W. Butler.

Potts, Henry William,

Euroa, Victoria.

Analytical Chemist. Trained in the Government Analytical Laboratory, Queensland, under Karl Theodor Staiger, Ph.D., F.L.S., &c., 1873 and 1874. Examiner in Chemistry to the Dental Board of Victoria, under Part II, "Medical Act," 1890—1888—1892.—*Government Gazette*, May 11th, 1888. Analyst to the Euroa Butter, Cheese, and Ice Factory Company, Limited, at which the "System of Payment by Results" was formulated and introduced, 1893. Author of several papers on "Milk Testing, Preserving, &c."

Baron Ferd. von Mueller, M.D.

L. R. Scammell.

J. Pond.

C. R. Blackett.

M. Carteighe.

A. W. Craig.

Power, Frederick Belding,

21, Queen Square, Bloomsbury, W.C.

Director of "the Wellcome Research Laboratories," 42, Snow Hill, E.C. Ph.D. of the University of Strassburg. Formerly Professor of Pharmaceutical Chemistry in the University of Wisconsin, U.S.A. Late Director of the American Laboratories of Schimmel & Co.

H. A. D. Jowett.

Wyndham R. Dunstan.

R. Meldola.

David Howard.

*Alfred G. Howard.***Russell, William,**

Summerlie, Coatbridge, N.B.

Analytical Chemist and Assayer. Four years in Glasgow City Analysts' Laboratory. Seven years Chemist to Summerlie & Mossend Iron and Steel Company. Four years Lecturer on Metallurgy at Coatbridge Technical School; presently with the Cassel Gold Extracting Co., Glasgow.

Robert R. Tatlock.

Horatio Ballantyne.

Alfred James.

John S. MacArthur.

Hugh Barclay.

Alexander M. Martin.

Saville, Arthur Edwin,

33, Richmond Terrace, Darwen.

Chemist and Assistant Manager of the Darwen Corporation Gas Works. Has had experience at Gas Works, Sulphate of Ammonia Works, and Tar Distillation Works, and is fully qualified to take over management of any or all of these. Has a sound, practical knowledge of Advanced Chemistry, both Organic and Inorganic.

Hy. Ellison, Jun.

Thos. Duxbury.

Francis Henry Tate.

*Geo. A. Milne.**E. Haworth.***Seabrooke, Herbert Cecil,**

The Echoes, Grays, Essex.

Research Assistant. Three years student Finsbury Technical College. Two years with Dr. Moritz and Dr. Morris, past 18 months as Research Assistant. Associate of the Institute of Chemistry.

G. Harris Morris.

E. R. Moritz.

W. W. Cheadle.

Horace T. Brown.

J. H. Millar.

Shimomura, Kotaro,

Dotemachi, Kioto, Japan.

Professor of Chemistry, Harris School of Science, Kioto. S.B. (Worcester Polytechnic Institute, Worcester, Mass., U.S.A., 1888). Studied under Professor Ira Remsen, Johns Hopkins' University, 1888—1889. Director and Professor of Chemistry in Harris School

of Science, 1889—1896. Papers: "On the Theories in regard to the Formation and Composition of the 'Chemical Elements,'" 1888; experimental work "On the Oxidation of certain Aromatic Isomeric Compounds," submitted to Remsen, 1895.

Watson Smith. R. J. Friswell. Edward Kinch.
Arthur J. Dickinson. William Ramsay.

Sodeau, William Horace, B.Sc. (Lond.), A.I.C.,

25, Shore Road, South Hackney, N.E.

Assistant Demonstrator of Chemistry, King's College, London. Educated at King's College, London. Obtained the "Daniell Scholarship" in Chemistry at that College in 1891. Passed the Intermediate Science Examination in 1893 with "1st Class Honours in Chemistry and Physics," and "Neil Arnott Medal" in Physics. "Honours in Chemistry and Physics" at B.Sc. examination in 1895.

John M. Thomson. W. D. Halliburton.
Herbert Jackson. Wyndham R. Dunstan.
Patrick H. Kirkaldy. A. K. Huntington.

Thompson, Charles,

Grammar School, Coatham, Redcar.

Science Master. B.Sc. degree of London University in Chemistry, Physics, and Geology. A Teacher of Chemistry for five years. Holder of Honours Certificates in Chemistry from Science and Art Department.

J. E. Stead. Jno. Archyll Jones.
Alex. F. Hogg. Wm. Whitehouse.
H. Frankland. E. H. Saniter.
C. H. Ridsdale. H. E. Wright.

Walker, William Henry.

Stafford Street, Willenhall, Staffs.

Manufacturing Chemist. Four years Student of Chemistry, Free Library Science School, Wolverhampton. Six months Student in Laboratory of Mr. F. H. Alcock, F.I.C., Birmingham. 1st Class Honours Practical Chemistry (Science and Art Department). Associate Pharmaceutical Society (Minor Examination, 1896).

Wm. Whitehouse. Alfred Southall.
F. H. Alcock, F.I.C. W. F. Wyley.
H. W. Jones. W. H. Richardson.
Percy F. Frankland. J. H. Hichens, M.A.

Watson, William,

School House, Kingsbridge, S. Devon.

Headmaster of Kingsbridge Grammar School. Student Chemical and Physical Laboratories, Oxford. M.A. Oxford. Science Master,

Cowbridge Grammar School, Glamorganshire, 1881—1887. Teacher of Science under Devonshire County Council, 1892—1896.

Francis Jones. Arthur W. Clayden. Henry T. Gerrans.
Arthur E. Holme. R. L. Taylor.

Wheelwright, Edwin Whitfield,

The Oaklands, Warley, Oldbury, near Birmingham.

Research Chemist. Student of Chemistry in the Yorks. Coll., Leeds, 1884—8. Natural Science Scholar of Balliol College, Oxford, 1888. B.A. 1st Class Honours in Chemistry, Oxford, 1891. Ph.D. Munich, 1893.

Geo. S. Albright. A. Vernon Harcourt. T. E. Thorpe.
John Conroy. Arthur Smithells.

Whimster, John Inctus,

12, Rutland Terrace, Stockton-on-Tees.

Draughtsman in a Gas Works Contractor's Office. Student of Chemistry for 3 years in Sharp's Institution, Perth, passing Advanced stage Theoretical and Practical in the South Kensington Examinations. One year with Professor Percy Frankland and Dr. Thomson in University College, Dundee, where I was first in my year in Theoretical, Practical, and Analytical Chemistry; specially interested in the Chemistry of Gas Manufacture.

Percy F. Frankland. Andrew Thomson. John S. Lumsden.
John Foggie. Walter Jardine. James R. Appleyard.
Fred. J. Hambly.

Wigner, John Harrison.

58, Breakspear Road, St. John's, London, S.E.

Student. Doctor of Philosophy and Student of Chemistry in Heidelberg University, where he is doing research work under Professor Jannasch. Studied Chemistry previously for three years at Royal Colleges of Science, London and Dublin.

Jocelyn F. Thorpe. Thomas Gray. Alex. M. Kellas.
R. H. Harland. Bernard Dyer. Otto Hehner.

Wilcox, Alfred James,

The Grammar School, Guisborough, Yorks.

Tutor. Pupil ($2\frac{1}{2}$ years) W. F. Keating Stock, Esq., F.C.S., F.I.C., Public Analyst for the County of Durham. Teacher (5 years) including Magdalen College School, Brackley, Northants, and Guisborough Grammar School. Organised Science School under S.K. Department.

W. F. Keating Stock. S. A. Sadler. M. Smith.
H. T. Sorrelli. A. C. Wilson.

PROCEEDINGS
OF THE
CHEMICAL SOCIETY.

EDITED BY THE SECRETARIES.

No. 170.

Session 1896-97.

Nov. 19th, 1896. Mr. A. G. Vernon Harcourt, President, in the Chair.

Mr. W. H. Merrett was formally admitted a Fellow of the Society.

Certificates were read for the first time in favour of Messrs. William Ross Innes, B.Sc., Ph.D., Mason College, Birmingham; Theophilus Henry Lee, Hampden House, Phoenix Street, N.W.; Frank Southerden, 75, Barry Road, Dulwich, S.E.; Basil William Turner, Collins Street, Annandale, Sydney, N.S.W.

The certificates of the following Candidates, recommended by the Council under Bye-law I, par. 3, were also read:—

Gopal Chandra Banerjee, Cawnpore, N.W.P.; Eric David Ewen, Port of Spain, Trinidad.

Of the following papers those marked * were read.

- *144. "Sulphocamphoric acid and derivatives of camphorsulphonic acid."
By Arthur Lapworth, D.Sc., and Frederic Stanley Kipping, Ph.D., D.Sc.

The compounds obtained by treating α -bromocamphorsulphonic acid with nitric acid and with potassium permanganate respectively under various conditions, have been examined, and are described in this paper. The action of nitric acid, as stated in an earlier note (Proc., 1896, 12, 77), gives rise to the formation of a *hydroxy-dibromocamphorsulphonic acid* of the composition $C_{10}H_{11}Br_2SO_5$, a *sulpholactone* of the composition $C_{10}H_{12}Br_2SO_4$, and a substance which

was thought to be sulphocamphoric acid, but which was isolated only in the form of its ammonium dihydrogen salt.

An ammoniacal solution of potassium permanganate was found to be much more suitable than nitric acid for the oxidation of α -bromocamphorsulphonic acid, and with this reagent the principal product is sulphocamphoric acid, a simple substitution derivative of ordinary *d*-camphoric acid.

Sulphocamphoric acid, $\text{SO}_3\text{H}\cdot\text{C}_8\text{H}_{13}(\text{COOH})_2$, crystallises from aqueous solution in large, striated plates, which contain water of crystallisation, and from ethylic acetate in beautiful, transparent, pyramidal crystals which effloresce on exposure to the air; the anhydrous acid melts at 188° , at which temperature it is probably converted into its anhydride. It is very readily soluble in water, alcohol, acetic acid, and acetone, and has all the ordinary properties of sulphonic acids; several of its salts are described.

Sulphocamphoric anhydride, obtained by heating the acid with acetic anhydride, crystallises from ethylic acetate in long, colourless needles, melts at $220\text{--}222^\circ$, and is nearly insoluble in benzene and chloroform.

$\text{SO}_2\text{BrC}_8\text{H}_{13}\langle\begin{smallmatrix}\text{CO}\\\text{CO}\end{smallmatrix}\rangle\text{O}$, the *sulphonic bromide of camphoric anhydride*, is formed when sulphocamphoric acid is triturated with phosphorus pentabromide. It crystallises from ethylic acetate in minute, pyramidal crystals, melting at $169\text{--}171^\circ$, and is not appreciably soluble in chloroform or benzene, but dissolves to a slight extent in hot carbon tetrachloride, carbon bisulphide, and xylene. When heated at its melting point, the sulphonic bromide decomposes into sulphur dioxide and a compound which was proved to be identical with π -bromocamphoric anhydride; this fact shows that sulphocamphoric acid is derived from *d*-camphoric acid by the substitution of the sulphonic group for one atom of hydrogen.

$\text{SO}_2\text{Cl}\cdot\text{C}_8\text{H}_{13}\langle\begin{smallmatrix}\text{CO}\\\text{CO}\end{smallmatrix}\rangle\text{O}$, the *sulphonic chloride of camphoric anhydride*, prepared by treating sulphocamphoric acid with phosphorus pentachloride, crystallises from ethylic acetate in octahedra, needles, or prisms, according to the conditions, and melts and decomposes at 184° ; it resembles the corresponding sulphonic bromide in ordinary properties, and when heated at its melting point it is converted into π -chlorocamphoric anhydride with evolution of sulphur dioxide.

π -*Chlorocamphoric acid*, $\text{C}_{10}\text{H}_{13}\text{Cl}(\text{COOH})_2$, is obtained by dissolving the crude anhydride in concentrated nitric acid, and then evaporating the solution; it forms beautiful, transparent, apparently orthorhombic crystals, and has no definite melting point, liquefying gradually from about $195\text{--}213^\circ$ according to the conditions. This compound is

doubtless a derivative of *d*-camphoric acid, and is therefore an optical isomeride of the π -chlorocamphoric acid which is produced by the oxidation of optically inactive π -chlorocamphor.

π -Chlorocamphoric anhydride separates from a mixture of chloroform and ether in large, transparent prisms, melts at 196–197°, and resembles π -bromocamphoric anhydride in its general behaviour.

***145. "A compound of camphoric acid and acetone." By William Jackson Pope.**

Dextrocamphoric acid crystallises from acetone in large, transparent tablets, which belong to the orthorhombic system, and show the forms {100}, {010}, {110}, {120}, and {011}; $0.8586 : 1 : 1.2386 = a : b : c$. Although the substance is optically active in solution, no indication of hemihedral structure could be observed. The crystals have the composition $C_{10}H_{16}O_4 \cdot \frac{1}{2}Me_2CO$, and in warm weather effloresce slowly, losing their acetone of crystallisation.

These crystals seem to bear no morphotropic relationship to the ordinary monoclinic crystals of camphoric acid, but are closely related to the orthorhombic crystals of camphoric anhydride. If the forms observed on the latter be described as {010}, {001}, {011}, {012}, and {101}, the axial ratios become $a : b : c = 1.0027 : 1 : 1.7216$; similarly the indices of the forms observed on the compounds of camphoric acid and acetone may be described as {010}, {001}, {011}, {012}, and {110}, whilst the axial ratios simultaneously change to $a : b : c = 1.2386 : 1 : 1.7172$. It thus becomes evident that of the five forms present on each set of crystals, four lying in one zone, namely, {010}, {001}, {011}, and {012}, have the same indices on both; the further remarkable result is obtained that any angle in this zone on crystals of the one substance is practically equal to the corresponding angle in the same zone on the other set of crystals.

***146. "Mercury hyponitrites." By P. C. Rây, D.Sc.**

By the dissociation of mercurous nitrite a neutral solution is obtained containing both mercurous and mercuric nitrites. When this solution is mixed with a dilute solution of sodium hyponitrite, both mercurous and mercuric hyponitrites are apparently formed.

Mercurous nitrate, when similarly treated, does not yield a hyponitrite.

***147. "The nitrites of mercury and the conditions under which they are formed." By P. C. Rây, D.Sc.**

The author finds (1) that mercurous nitrite is always formed by the action of dilute nitric acid (10 to 23 per cent.) on mercury at a

temperature of about 32° . (2) That the mercurous nitrite thus formed slowly dissolves in the mother liquor, resulting in the production of mercurous nitrate of two kinds:—(a) Monohydrated mercurous nitrate, $\text{Hg}_2(\text{NO}_3)_2 + 2\text{H}_2\text{O}$; and (b) the basic nitrate, named "Marignac's salt." (3) That when a neutral dilute solution of mercurous and mercuric nitrites (the products of dissociation) is allowed to evaporate spontaneously, monohydrated mercurous nitrite, $\text{Hg}_2(\text{NO}_2)_2 + \text{H}_2\text{O}$, and two basic mercurous-mercuric nitrites and a basic mercuric nitrite are successively formed. (4) That of these salts only two may be said to contain real "water of crystallisation," namely, those termed monohydrated mercurous nitrite and nitrate respectively, in that they are efflorescent, losing water rapidly in a dry atmosphere. The others apparently contain "water of constitution."

*148 "The interaction of mercurous nitrite and the alkyl iodides." By P. C. Rây, D.Sc.

By the interaction of ethyl iodide and mercurous nitrite the author has apparently obtained ethyl nitrite and nitro-ethane.

149. "Crystallography of the monohydrated mercurous nitrite." By T. H. Holland, F.G.S.

The crystals belong to the triclinic system, and exhibit strong double refraction. Macropinacoidal sections show an extinction angle of 33° to the vertical crystallographic axis.

*150. "On the identity of dextrose from different sources; with special reference to the cupric oxide reducing power." By C. O'Sullivan, F.R.S., and A. L. Stern, D.Sc.

Dextrose was prepared from sugar (cane and beet), starch, and lactose, and the optical activity, the cupric oxide reducing power, and the specific gravity of the aqueous solutions of each specimen determined. These factors were found to be the same for each of the different specimens of dextrose, and consequently from this evidence it is concluded that the dextroses from various sources are identical.

The figures obtained for the cupric oxide reducing power are practically the same as Allihn's, which are in common use in Germany, although the former were obtained by proceeding according to the directions previously given by O'Sullivan, which, however, do not differ materially from Allihn's. A modified form of filtering tube is described, which was found to possess several advantages.

151. "Note on Mr. W. J. Humphreys' paper on the solution and diffusion of certain metals in mercury." By Professor Roberts-Austen, C.B. F.R.S.

IN the April number of the Transactions, 69, 243, there is an interesting communication on the above subject by Mr. Humphreys, who is the first to publish results in continuation of Guthrie's experiments (1883) on diffusion in mercury, and his work is, therefore, very welcome. As, however, I have, at intervals since 1882, conducted experiments on the diffusion of molten metals (Bakerian Lecture, *Phil. Trans.*, 1896, 187), I would briefly refer to certain portions of Mr. Humphreys' work that are difficult to interpret by calculation, and I may offer a few suggestions in the hope that they will be useful in future work.

Mr. Humphreys has not attempted to calculate absolute *diffusivities* from the results of his well devised experiments. It is, in fact, very difficult to do so on account of his having used a solid metal instead of a dilute amalgam, from which diffusion into mercury took place. Guthrie did the same, and this precludes the possibility of using the results of either experimenter for calculating absolute diffusivities by the direct application of Stefan's tables (Stefan, *Wien. Akad. Ber.*, 1879, 79, 161; see also Roberts-Austen, *loc. cit.*).

Approximate results by calculation appear to show, however, that there is a general concordance between the results of Guthrie and of Humphreys, but more satisfactory results would be afforded if Mr. Humphreys arranged his experiments with a view to their final calculations by means of Stefan's tables.

It is hardly necessary to say that the use of a solid metal diffusing into a fluid one, solid silver into mercury for instance, would introduce the complications arising from the fact that amalgamation or solution of the solid metal must necessarily precede diffusion, and it is very difficult to fix the degree of concentration of the dissolved metal in the layer of amalgam so formed, from which diffusion actually takes place.

Mr. Humphreys states that the rate of diffusion of silver and copper into mercury is 600 times as rapid as that of zinc into mercury, and he expressed a doubt whether this might not be due to superior density of silver amalgam as compared with mercury. Some 46 years ago, Joule (*Collected Papers*, 1, 460), working on amalgams of silver and of copper, gave evidence which points to the conclusion that dilute amalgams of these metals would prove to be denser than mercury itself. Mr. Humphreys used single tubes filled with mercury, and silver and copper were respectively placed at the top of fluid columns. The diffusion of silver must be studied by the

use of dilute amalgams diffusing upwards, and if, for the purpose of demonstration, Mr. Humphreys will employ U-tubes, as Mr. Stansfield has recently in my laboratory, he will find the amalgamated silver falls rapidly down one limb by density, and slowly rises by diffusion through the mercury in the opposite limb, the diffusivity of silver being, in fact, of the same order as that of zinc which Mr. Humphreys considered to diffuse so slowly.

152. "Solution and diffusion of certain metals and alloys in mercury. Part II." By W. J. Humphreys.

The author has extended this investigation (Proc., 1896, 12, 9) to aluminium, antimony, cadmium, magnesium, thallium, and a few alloys. Aluminium and antimony diffuse in mere traces. The cadmium amalgam heavier than mercury was not formed. The author considers that solution and diffusion in mercury may serve to distinguish between mixtures and compounds in the case of alloys. Metals that belong to the same group in Mendeléef's table increase in their power of solution and diffusion with their atomic weight.

153. "Note on the heat of formation of the silver amalgam, Ag_2Hg_3 ." By Fannie T. Littleton.

In a previous communication (Trans., 1895, 67, 239) an account was given of a silver amalgam exhibiting remarkable behaviour on being moderately heated, swelling up as if from the evolution of gas, and becoming hard, brittle, and crystalline in structure. It was noted that this behaviour was most marked when the silver and mercury were present in the ratio of 1 atom of the former to 4 of the latter, and that, when these metals were brought together, the silver in the state of a fine, crystalline powder (as reduced from the pulverulent chloride by zinc and a little hydrochloric acid), and the mercury simply poured over it, there was very considerable rise of temperature, amounting to 38° or 40° ; so that the amalgam could not be borne on the palm of the hand without pain.

No actual measurement of the heat evolved in the formation of the amalgam was made. Such measurements have recently been made in a simple form of calorimeter, with the following result.

If the formula assumed for the amalgam be Ag_2Hg_3 , and the molecular weight be taken as 1813.8 ($\text{H} = 1$), the heat evolved in the formation of one molecule is equal to about 3432 units, the molecular weight being counted in grams, and the unit of heat as the heat required to raise the temperature of 1 gram of water (at about 22°) by 1° . These determinations gave the values 3395, 3413, and 3484. It is to be observed that the amalgam, just after its production, is a soft, pasty, semi-fluid mass. Calculating from Person's

figures, for the latent heat of fluidity of the metals concerned, 1813·8 grams of the amalgam consists of 215·4 grams of silver, the fusion of which would absorb 4537 heat units and 1598·4 grams of mercury, the solidification of which would evolve 4507 heat units.

Two nearly agreeing determinations of the specific heat of the amalgam, in its freshly formed condition, gave an average value of 0·029 referred to an equal weight of water as unity. This is notably below 0·0359, the result of calculation from the specific heats of the respective metals, assuming these to remain unchanged in the amalgam.

154. "Preliminary note on the action of alkyl iodides on silver malate."

By Thomas Purdie, F.R.S., and G. Druce Lander, B.Sc.

In a recent communication to the Society (Purdie and Williamson, Trans., 1896, 69, 818) on the optical activity of ethereal malates and lactates prepared by different methods, it was shown that, while the action of methylic, ethylic, *n*-propylic, and *n*-butylic iodides on silver malate proceeded apparently in the normal manner, the action of isopropylic iodide was anomalous. The ethereal salt obtained from the latter reaction was small in quantity; the percentages of carbon and hydrogen found on analysis were considerably higher than the numbers calculated for isopropylic malate, and the liquid showed a much higher activity than this substance should possess. The authors have repeated the experiment on a larger scale, and find that the high activity of the product is due to the presence in it of about 20 per cent. of isopropylic isopropoxysuccinate. It appears that the isopropyl group of the iodide replaces, not only the silver of the malate, but also, to a considerable extent, the hydrogen of its alcoholic hydroxyl.

The isopropylic isopropoxysuccinate was obtained by the partial hydrolysis of the product of the reaction, the malate being more easily hydrolysed than the other compound. The rotation of the mixture produced by the reaction was $\alpha = -32·96^\circ$ ($l = 1$), that of the isopropoxysuccinate was $-57·08^\circ$. The results of the analysis of the ethereal salt, and also of the barium, calcium, and potassium salts obtained from it, were in agreement with the calculated numbers. The specific rotations in aqueous solutions of varying concentration were determined for the acid, also for the barium, calcium, acid potassium and normal potassium salts, and were found in general to approximate to the corresponding numbers for active normal propoxysuccinic acid prepared by resolution of the inactive compound (Traus., 1895, 67, 949).

In the paper on ethereal malates and lactates (*loc. cit.*) it was pointed out that the ethereal salts made from the silver salt possessed

in every case a notably higher activity than those made by the hydrochloric and sulphuric acid methods. The obvious conclusion that the difference was due to the presence of racemoid substance in the latter compounds was negatived by experiments which failed to detect in them such a quantity of racemoid compound as would account for their lower activity. The cause of the anomaly was left unexplained. After the authors had discovered, however, that isopropoxysuccinic acid was produced in considerable quantity by the reaction of isopropyl iodide on silver malate, it seemed probable that the higher activity of the other malates, made by the same method, might also be due to their being contaminated with small quantities of the corresponding alkyloxysuccinates. In the case of ethylic malate an admixture of about 4 per cent of ethylic ethoxysuccinate would suffice to account for the higher observed activity; its presence could not be detected by analysis, nor in the course of ordinary fractional distillation, the differences in the boiling points of the substances being inconsiderable.

To test the correctness of the suggested explanation, the authors prepared ethylic malate from the silver salt on a large scale. The crude product boiled at $130-135^{\circ}$ at about 15 mm., and showed the activity $\alpha = -13.93^{\circ}$ ($l = 1$). On redistillation, the activity of the first fraction collected showed a rise of about 1° , and after often repeated fractional distillation, two fractions were finally obtained, differing in boiling point by only about 3° , the lower boiling fraction, however, having the activity $\alpha = -17.05^{\circ}$ ($l = 1$), and the higher boiling $\alpha = -12.26^{\circ}$. By partial hydrolysis of the former fraction, the activity of the unhydrolysed oil was raised to -20° . The rotation of ethylic malate made by the mineral acid methods was previously found to be $\alpha = 11.7^{\circ}$. The ethylic malate made by the silver salt method is, therefore, evidently contaminated with a small quantity of a much more active compound, and although efforts to isolate the substance in the pure state have so far been unsuccessful, it is very probable, judging from the case of isopropyl iodide, that the compound in question is ethylic ethoxysuccinate.

Experiments show that the ethereal salts of malic acid, and, no doubt, of other hydroxy-acids, cannot be obtained in the pure state from the silver salt; by the action of isopropyl iodide, isopropyl isopropoxysuccinate is produced in quantity, and the higher activities found for other malates prepared by this method, which are quoted in the paper referred to, are due probably to the presence of small quantities of the ethereal salts of the highly active alkyloxy-acids. The high activity of the ethereal lactates made from the silver salt, which the authors are at present examining, will probably find a similar explanation.

The authors are not aware that the production of alkyloxy-acids by the action of alkyl iodides on silver salts of hydroxy-acids has ever been observed. The reaction is remarkable, and the authors are investigating it further.

155. "On certain thiocarbimides derived from complex fatty acids."
By Augustus E. Dixon, M.D.

In this paper an account is given of the preparation of thiocarbimides derived from palmitic and stearic acids; the compounds in question, if brought into contact with organic bases, afford the corresponding substituted thiocarbamides, or thioureas; from these, in turn, by suitable treatment with silver compounds, their oxygen analogues may be obtained.

Palmitylthiocarbimide, $C_{15}H_{31}CO \cdot NCS$, is an easily fusible, soft solid, of faintly pungent odour; it distils, with considerable decomposition, between 200° and 205° , and is attacked by water, yielding palmitic and thiocyanic acids. *ab-Palmitylphenylthiocarbamide*, $C_{15}H_{31}CO \cdot NH \cdot CS \cdot NHPh$, crystallises from alcohol in slender, waxy-looking needles, insoluble in water, soluble in the ordinary organic solvents, and melting at $62-63^{\circ}$ (uncorr.). The corresponding *urea* forms microscopic needles; m. p. $90-91^{\circ}$. *ab-Palmitylorthotolylthiocarbamide*, $C_{15}H_{31}CO \cdot NH \cdot CS \cdot NHo-To$, felted white needles, melting between 65.5° and 66.5° . The *urea* occurs in woolly masses of flexible needles; m. p. 98° . *ab-Palmitylparatolylthiocarbamide* and *palmitylparatolylurea*, fine needles, melting at $75-76^{\circ}$. and $89-90^{\circ}$ respectively. $C_{15}H_{31}CO \cdot N:C(SH) \cdot NMePh$, *n-Palmityl- ν -methylphenylthiourea*, white needles; m. p. $59-60^{\circ}$. *n-Palmityl- ν -phenylbenzylthiourea*, $C_{15}H_{31}CO \cdot N:C(SH) \cdot NPhBz$, was obtained in nearly quantitative amount; it melts at $62-63^{\circ}$, and by desulphurisation affords the *urea*, $C_{15}H_{31}CO \cdot NH \cdot CO \cdot NPhBz$, pearly needles of m. p. $68-69^{\circ}$. *ab-Stearylorthotolylthiocarbamide*, $C_{17}H_{35}CO \cdot NH \cdot CS \cdot NHo-To$, is deposited from absolute alcohol in very fine, white needles, melting at $67-68^{\circ}$; by treatment with silver nitrate it affords *stearylorthotolylurea*, m. p. $94-95^{\circ}$. $C_{17}H_{35}CO \cdot NH \cdot CS \cdot NH \cdot C_6H_5Me_2$, *ab-Stearylmeta-xylylthiocarbamide*, lustrous needles, melting at $71-72^{\circ}$; the corresponding *urea* melts at $92-93^{\circ}$. *ab-Stearylalphanaphthylthiocarbamide* melts at $80-81^{\circ}$; the *urea* at $114-115^{\circ}$. *n-Stearyl- ν -phenylbenzylthiourea*, $C_{17}H_{35}CO \cdot N:C(SH) \cdot NPhBz$, melts at $66-66.5^{\circ}$, and by desulphurisation affords the *urea*, $C_{17}H_{35}CO \cdot NH \cdot CO \cdot NPhBz$; the latter forms white needles, becoming electrical on friction, and melting between 74° and 75° .

It is stated by Miquel (*Ann. Chim. Phys.*, [5], **11**, 316) that benzoylthiocarbimide, $PhCO \cdot NCS$, even if heated at 200° with diethylamine, remains unaltered; the author finds, however, that solutions

of these two substances, in benzene and alcohol respectively, interact spontaneously, with marked evolution of heat and production of *n-benzoyl-p-diethylthiourea*, $\text{PhCO}\cdot\text{N}\cdot\text{C}(\text{SH})\cdot\text{NEt}_2$. The latter forms long, brilliant prisms, sparingly soluble in boiling water; m. p. $100-101^\circ$ (corr.).

At the next meeting on Thursday, December 3, there will be a ballot for the election of Fellows, and the following papers will be received:—

“Constitution and Colour.” By Arthur G. Green.

“Some experiments on sea-water.” By E. Sonstadt.

“Derivatives of α -Hydrindone.” By C. Revis and F. Stanley Kipping, Ph.D., D.Sc.

“Notes on nitration.” By H. E. Armstrong.

“2:3'-Bromobetanaphthol.” By H. E. Armstrong and W. A. Davis.

“Derivatives of nitrobetanaphthols.” By W. A. Davis.

“Morphotropic relations of betanaphthol derivatives.” By W. A. Davis.

“Researches on tertiary benzenoid amines.” By Miss C. Evans.

The following Candidates are recommended by the Council under Bye-law I (3):—

Bauerfee, Gopal Chandra,

Cawnpore, N. W. P. of India.

Practical Chemist, Soap and Candle Maker and Perfumer. Maker of Kaiser Lubricating Oil. Undergraduate of the Calcutta University (in Science). The first manufacturer in India of soaps from pure vegetable oils, was awarded first class Certificate and Silver Medal in the Calcutta International Exhibition of 1883-84, proprietor and manager of the Kaiser Soap Manufacturing Company, and managing director of the Cawnpore Candle Works, Limited, member of the Society of Arts, London.

Abhayachoran Sanyal, Professor Physical Science, Queen's College, Benares, India.

Ewen, Eric David,

Port of Spain, Trinidad, B.W.I.

Research Chemist. Expert on Guttas, Rubbers, and Asphalts. Consulting Chemist to several mining and manufacturing companies.

Walter H. Ince.

PROCEEDINGS

OF THE

CHEMICAL SOCIETY.

EDITED BY THE SECRETARIES.

No. 171.

Session 1896-97.

Dec. 3rd, 1896. Mr. A. G. Vernon Harcourt, President, in the Chair.

Certificates were read for the first time in favour of Messrs. James Herbert Brown, Dallas Place, Lancaster; John Wallis Dodgson, B.Sc., 47, Hirwain Road, Aberdare, Glamorgan; Lawrence Dufty, 33, Broomball Place, Sheffield; Joseph Lake Gibbons, West Carlton Street, Blyth; Alexander William Gilbody, M.Sc., Ph.D., Owens College, Manchester; Harold Walter Gough, B.A., 73, Billing Road, Northampton; Ernald George Justinian Hartley, B.A., Wheaton Aston Hall, Stafford; Charles Henry Martin, 14, Aldred Street Crescent, Salford; William James Stainer, B.A., 3, Havelock Road, Stanford Avenue, Brighton; Samuel Matthew Walford, 62, Bloom Street, Stockport; James Wallace Walker, M.A., Ph.D., University College, London.

The following were duly elected Fellows of the Society: Henry Edward Aykroyd, William Ballingall, M.A., Gopal Chandra Banerjee, Charles Bathurst, B.A., Lauritz Hansen Bay, Charles Edward Browne, B.Sc., Walter William Cobb, M.A., George Harold Cross, B.Sc., William Duncan, Walter John Elliott, M.A., Eric David Ewen, John Thomas Fleet, George George, Arthur Croft Hill, B.A., Charles Alexander Hill, John William Hinchley, William Trevor Lawrence, B.A., Robert Dexter Littlefield, Thomas Henry Lloyd, Thomas William Lockwood, Hugh Manners, M.A., B.Sc., Edward Seaborn Marks, Arthur Stanley Mayfield, William M. Miller, Landon Clarence Moore, Francis Ambrose Moss, Herbert William Moss, Joseph Terrence de la Mothe, Alexander Henry Mitchell Muter,

William Harrison Pearsall, Henry William Potts, Frederick Belding Power, Ph.D., William Russell, Arthur Edwin Saville, Herbert Cecil Seabrooke, Kotaro Shimomura, B.Sc., William Horace Sodeau, B.Sc., Charles Thompson, B.Sc., William Henry Walker, William Watson, M.A., Edwin Whitfield Wheelwright, B.A., Ph.D., John Inctus Whimster, John Harrison Wigner, Ph.D., Alfred James Wilcox.

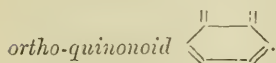
Of the following papers those marked * were read.

*156. "Constitution and colour." By Arthur G. Green.

In a scheme for the qualitative analysis of the coal-tar colouring matters published in 1893 (*J. Soc. Chem. Ind.*, 1893, **12**, 3), the author pointed out that the leuco-compounds of various dye-stuffs exhibit a striking difference of behaviour on exposure to air. Leaving out of account those which are completely split up by reduction (viz., azo-, nitro-, and nitroso-colours), it is possible, by means of this reaction, to classify colouring matters into two groups, viz.:—I. Colours whose leuco-compounds are not readily reoxidised on exposure to air. II. Colours whose leuco-compounds are rapidly reoxidised on exposure to air.

Group I comprises all the colouring matters of the triphenyl-methane series, the phthaleins or pyrone colours, indophenols, and indamines. Group II comprises the indigo class, the azines, azonium colours, oxazines, thiazines, acridine colours, thiazol colours, quino-line colours, oxyanthraquinone colours, and certain colouring matters of unknown constitution.

In explanation of the cause underlying this difference of behaviour, the author, in 1892, put forward the suggestion (*Proc.*, 1892, **8**, 195) that, assuming the correctness of the "quinonoid" theory of colour (Armstrong, *Proc.*, 1888, **4**, 27; 1892, **8**, 101, 143, 189, and 194; 1893, **9**, 52 and 206), the colouring matters of the first group might be regarded as *para-quinonoid* $= \langle \text{C}_6\text{H}_4 \rangle =$, of the second group as



In the present paper, this view is more fully discussed, and further evidence is brought forward in confirmation of it.

An examination of the members of the two groups shows that, whilst nearly all the colouring matters of Group I are compounds substituted in the para-position alone, no plain para-substituted compounds are found in Group II; on the other hand, whilst Group II contains compounds substituted in the ortho-position alone (*e.g.*, indigo) and compounds substituted in both positions, no plain ortho-substituted compounds are to be found in Group I. Therefore, if

the "quinonoid" theory of colour be accepted, it follows that dye-stuffs, which, from their constitution, must be ortho-quinonoid, only occur in Group II, whilst those which must be para-quinonoid only occur in Group I.

In Group I, the theory agrees in all cases with the usually accepted constitution of the colours. In Group II, when it is not in accord with the usually accepted view, the ortho-quinonoid formulæ give as good, or better, interpretations to the properties of the colouring matters, than the para-quinonoid formulæ previously assigned them.

It would be anticipated, from the well-known inter-relationship of ortho-substituents, that two groups occurring in an ortho-position to each other would have a greater tendency to enter into a more intimate union, and therefore would be more oxidisable than if they stood in the para-position.

The stability towards acids of the colouring matters of the methylene-blue and safranin series, and the oxidisability of their leuco-compounds, compared with the extreme instability to acids of the parent indamines (paraquinone-imides) and non-oxidisability of their leuco-compounds, forcibly suggest a change of type.

The tendency exhibited by many azines and oxazines to form amido-derivatives by addition, as in the case of Meldola's blue, can only receive an explanation by the assumption of an ortho-quinonoid structure, since, in the naphthalene nucleus, where the substitution takes place, a para-quinonoid structure is not possible.

DISCUSSION.

Dr. KIPPING said that Mr. Green's classification of certain dye-stuffs into derivatives of ortho- and of para-quinones respectively, being based solely upon the rapidity with which the corresponding leuco-compounds undergo aerial oxidation, it would add to the interest of his communication if he could define more exactly the words "easily oxidised" by introducing the element of time; for the rapidity of oxidation of all the leuco-compounds of one class would probably not be the same, and consequently those reduction products of paraquinones which oxidised most easily might do so more rapidly than the leuco-compounds of some of the orthoquinones. Should this never, or rarely, occur, Mr. Green's classification would be extremely useful, but as it does not even include all dye-stuffs, it cannot be regarded as affording any support to the view held by Dr. Armstrong, namely, that *all* coloured carbon compounds have a quinonoid structure. This view, attractive though it may be, and supported by the numerous examples which have been brought

under notice, is nevertheless untenable: that all quinones and their derivatives are coloured may be true, but to assume that all coloured substances are quinones would necessitate in many cases the adoption of constitutional formulæ utterly at variance with chemical facts. Without discussing the meaning of the somewhat vague word "colour," it may be pointed out that the colour of a substance depends, amongst other conditions, on its crystalline structure. In the course of some work carried out with Mr. Revis, it was noticed that isonitrosohydrindone forms a yellow sodium derivative, the colour of which depends on the temperature at which it is crystallised; when heated at 70—80°, the yellow salt is rapidly converted into a scarlet modification, owing to a change in crystalline form taking place. Numerous examples of a similar kind are known, and taking this fact into consideration, and having regard more especially to the number of undoubted exceptions to Dr. Armstrong's colour rule, it is impossible to accept his generalisation in its present form.

Mr. LING agreed in considering that the quinone theory was not established as a general rule.

Dr. ARMSTRONG thought that Mr. Green's generalisation was of considerable value as a working hypothesis, but he was inclined to doubt whether it would be possible by means of such a test as that suggested to sharply divide dye-stuffs into two classes; it was rather to be expected that the members of the two classes would merge gradually into each other. As the method would in many cases incite the further investigation of structure, which was so much to be desired, it must prove to be of considerable service. As to the alternative formulæ suggested by Mr. Green, he could not regard them as satisfactory on the whole; the representation of oxygen as a tetrad in such a case as that of Meldola's blue, for example, appeared to him to involve conclusions beyond the bounds of probability. Mr. Green had spoken of the Armstrong-Nietzki quinonoid theory of colour: unaccustomed as he was to put forward claims of priority, he could not help remarking that although Nietzki had undoubtedly called attention to the occurrence of quinonoid structure in many colouring matters, he had never attempted to generalise. He, the speaker, had, however, endeavoured to extend the hypothesis not only to colouring matters, but to coloured substances generally, and had given a definition of the term quinonoid, which included even substances such as iodoform. No doubt the difficulties to be overcome were very great, and it would be long before we should be able to explain all cases of the occurrence of colour; meanwhile all we could do was to patiently investigate the facts.

Mr. GREEN, in reply, wished it to be understood that he regarded

the quinone theory as affording a satisfactory explanation of the colour of organic dye-stuffs, though not of the colour of all coloured organic compounds.

*157. "Derivatives of α -hydrindone." By C. Revis and F. Stanley Kipping, Ph.D., D.Sc.

As α -hydrindone and camphor are in some respects analogous in constitution (inasmuch as each contains two closed carbon chains, in one of which occurs the group $-\text{CH}_2\cdot\text{CO}-$), the behaviour of the two ketones and of corresponding derivatives has been studied, in order to ascertain to what extent they would show analogous reactions; it has thus been found that except in a few instances there is a marked difference in chemical behaviour.

α -Hydrindoneoxime, for example, behaves quite unlike camphoroxime when heated with mineral acids, as it yields the two condensation products (anhydrobishydrindone and truxene) which are produced from hydrindone itself (Kipping, *Trans.*, 1894, **65**, 480). Monobromohydrindone, unlike α -bromocamphor, is readily acted on by alcoholic potash, giving a condensation product of the composition $\text{C}_{18}\text{H}_{13}\text{BrO}_2$ (*Proc.*, 1895, **10**, 157). Dibromohydrindone resembles α -dibromocamphor in withstanding the action of nitric acid, but it differs from the camphor derivative in being readily acted on by alcoholic potash, giving a condensation product of the composition $\text{C}_{18}\text{H}_{11}\text{BrO}_2$; this substance crystallises from benzene in flat prisms, which contain one molecule of benzene, and melts at about 150° , also decomposing. A somewhat similar condensation product is obtained by treating dibromohydrindone with an alcoholic solution of sodium ethoxide; this compound crystallises in prisms melting and decomposing at 173 – 174° , and probably has the composition $\text{C}_{11}\text{H}_{10}\text{O}_2\text{Br}\cdot\text{OEt}$.

Attempts to prepare hydrindene, C_9H_{10} , by first reducing hydrindoneoxime to the primary amine, $\text{C}_9\text{H}_9\cdot\text{NH}_2$, and then converting the base into the hydrocarbon by the ordinary methods, were not more successful than those previously made by König (*Inaug. Diss.*, Leipzig, 1889), owing to the production of resinous compounds in the various stages of the process.

Benzoylaminohydrindene, $\text{C}_9\text{H}_9\cdot\text{NH}\cdot\text{COPh}$, prepared from the base, crystallises in colourless needles, and melts at 142 – 143° .

Benzylideneaminohydrindene, $\text{C}_9\text{H}_9\cdot\text{N}:\text{CHPh}$, the condensation product of benzaldehyde and aminohydrindene, forms transparent prisms, melting at 74 – 75° .

Aminohydrindene oxalate crystallises in clusters of white, opaque prisms, and is rather sparingly soluble in cold methyl alcohol and in cold water.

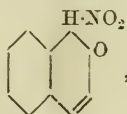
Hydrindone semicarbazide, $\text{C}_9\text{H}_9\cdot\text{N}\cdot\text{CO}\cdot\text{NH}\cdot\text{NH}_2$, separates from

dilute acetic acid in prisms, which contain 7 mols. of water; it melts and decomposes at about 239° .

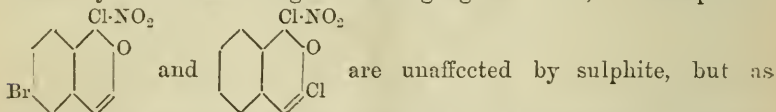
***158. "Notes on nitration." By Henry E. Armstrong.**

In previous notes on nitration (Proc., 1891, 7, 87-91), E. C. Rossiter and the author have drawn attention to the part played by keto-compounds, and to the explanation which their formation, as well as that of other addition compounds, affords of the production of secondary products in nitrations.

Attention is now drawn to the conditions to be observed in preparing normal products of nitration. However carefully β -naphthol be subjected to the action of nitric acid, a considerable proportion of resin is always formed, even when the product is subjected to the action of reducing agents; but if bromo- β -naphthol be used instead, the formation of resin may be entirely avoided, a practically theoretical yield of 1 : 2-nitro- β -naphthol being obtained. Obviously, in the latter case, the addition compound which is first formed, and also the keto-compound derived from it, are far less sensitive to the action of the unchanged naphthol, so that the interaction affording the resin is prevented from occurring. Moreover, although a nitro-keto-compound, such as is represented by the formula



would not be converted by reduction into nitronaphthol, it is to be expected that if bromine occupied the place of the hydrogen, it would be readily removable. Not only is this actually the case, but nothing more powerful than a sulphite is needed; yet, in some instances, it is necessary to use a stronger reducing agent: thus, the compounds



are unaffected by sulphite, but as experiments made by Mr. E. Rich show, they are at once converted into the corresponding nitronaphthols by means of hydrogen iodide.

***159. "3'-Bromo- β -naphthol." By Henry E. Armstrong and W. A. Davis.**

At present, the only bromo- β -naphthol known is the 1 : 2-modification, which is the sole product of the direct interaction of bromine and the naphthol; indirect methods capable of affording isomeric forms are much needed. The authors have succeeded in devising a method of converting 1 : 3'-dibromo- β -naphthol into 3'-bromo- β -

naphthol by removing the bromine atom in position 1; this consists in digesting the dibromo-compound with a saturated solution of hydrogen iodide, ultimately at a temperature not exceeding 65°. If care be taken, the yield is that indicated by theory; but if the naphthol be allowed to dissolve in the acid solution, and the temperature to rise too high, an intractable condensation product is alone obtained.

3'-Bromo- β -naphthol crystallises from benzene in colourless needles melting at 127°; the acetate derived from it melts at 103°.

On sulphonation by means of cold sulphuric acid, it yields a somewhat unstable monosulphonic acid, which is converted into 1 : 3'-dibromo- β -naphthol by bromine, and into 1-nitro-3'-bromo- β -naphthol by nitric acid; doubtless, therefore, sulphonation takes place in position 1.

By heating the bromonaphthol with excess of sulphuric acid at 100°, a stable disulphonic acid is produced.

The behaviour of higher brominated derivatives of β -naphthol and of the bromo- α -naphthols with hydrogen iodide will be considered in a subsequent communication.

*160. "Derivatives of nitro- β -naphthols." By W. A. Davis.

The difficulties which attend the nitration of β -naphthol do not affect that of its ethers, which show no tendency to give keto-compounds; moreover, the nitromethoxy- and nitrethoxy-naphthalenes are all more or less intensely coloured substances, whereas the corresponding phenol derivatives are colourless: hence the investigation of these compounds is of importance from several points of view.

Besides repeating and confirming Gaess's observations on the nitration of β -ethoxynaphthalene (*J. pr. Chem.*, [2], 43), the author has prepared the methoxy-compounds corresponding to those described by Gaess, and has subjected both series to crystallographic examination. 1 : 2-Nitromethoxynaphthalene (m. p. 126°) is the main product when nitration is effected in acetic acid solution at a temperature not exceeding 15°; it forms 90 per cent. of the total product, and is accompanied by about 1 per cent. of the 1' : 2-nitromethoxy- (m. p. 69°) and about 3 per cent. of the 3' : 2-nitromethoxy-compound (m. p. 134°).

The amido-derivatives were prepared by reducing the nitro-compounds with tin and hydrochloric acid. 1 : 2-amidomethoxynaphthalene melts at 84°, and its acetyl derivative at 175°; the 3' : 2-amido-compound melts at 98°, and its acetyl derivative at 183°, whilst 1' : 2-acetamidomethoxynaphthalene melts at 145°.

The action of a molecular proportion of bromine on 1 : 2-nitro-

ethoxynaphthalene gave 3' : 1 : 2-bromonitrethoxynaphthalene (m. p. 141°), the structure of which was determined by its formation on ethylating 3' : 1 : 2-bromonitronaphthol. When hydrolysed by alcoholic potash, it yields 3' : 1 : 2-bromonitronaphthol (m. p. 122°).

If any excess of bromine be used in the bromination, dibrom-ethoxynaphthalene (m. p. 94°) and tribromethoxynaphthalene (m. p. 128°) are formed by the displacement of the NO₂ group by bromine.

3' : 1 : 2-Bromamidoethoxynaphthalene melts at 84°, and its acetyl derivative at 246°.

3' : 1 : 2-Bromonitromethoxynaphthalene, prepared by brominating 1 : 2-nitromethoxynaphthalene, melts at 152°; the corresponding amido-compound melts at 73°, and its acetyl derivative at 252°. 3' : 1 : 2-Bromonitronaphthylamine, obtained by heating 3' : 1 : 2-bromonitrethoxy- or methoxynaphthalene with alcoholic ammonia at 160°, is a yellow, crystalline substance, melting at 190°.

On nitrating 1 : 2-nitromethoxynaphthalene with concentrated acid (*d* 1.42) at 0°, a mixture of 1 : 3' : 2- and 1 : 1' : 2-dinitromethoxynaphthalenes was obtained; these were separated only with difficulty. 1 : 3' : 2-Dinitromethoxynaphthalene was, however, obtained in a pure state by nitrating 1 : 3'-nitromethoxynaphthalene at 0°. It melts at 198°. The 1 : 1' : 2-dinitro-compound melting at 190° was obtained by similarly nitrating 1 : 1'-nitromethoxynaphthalene. The structure of these two dinitro-compounds was determined by converting them into the corresponding dinitronaphthylamines, which had been previously prepared and described by Gaess (*loc. cit.*).

1 : 2-Nitromethoxyuaphthalene, on being heated with alcoholic potash, easily yields 1 : 2-nitronaphthol; on being heated with alcoholic ammonia at 160°, it is converted into 1 : 2-nitronaphthylamine. It is noteworthy that, under similar conditions, 1 : 2-nitronaphthol yields scarcely any nitronaphthylamine, a large amount of resin being formed.

SO₂Cl₂ is apparently without action on 1 : 2-nitrethoxy- or nitromethoxynaphthalene; it acts, however, very readily on 1 : 2-acetamidomethoxynaphthalene, giving a beautifully crystalline monochloro-derivative, melting at 167°. The structure of this has not yet been determined. In order to determine whether β -ethoxy- α -naphthylamine resembles β -naphthol or α -naphthylamine, the behaviour of its acetyl compound with bromine was studied; the action was carried out at 0°. 3' : 1 : 2-Bromacetamidoethoxynaphthalene, m. p. 245°, was obtained as sole product. Thus its behaviour is simply that of a derivative of β -naphthol in which position 1 is occupied, the NHAc group, apparently, being without influence; this is of especial interest, as, according to a private communication from Professor

Nietzki to Professor Armstrong, its behaviour towards nitric acid is comparable with that of α -acetnaphthalide.

The behaviour of bromine with β -methoxy- α -acetnaphthalide is the same as towards the ethoxy-compound, 3' : 1 : 2-bromomethoxyacetnaphthalide (m. p. 252°) being obtained.

*161. "Morphotropic relations of β -naphthol derivatives."

By W. A. Davis.

Although the crystallographic relationships of benzene derivatives have been very fully investigated, little work of a similar character has been hitherto carried out upon naphthalene compounds, and only one morphotropic series of derivatives has been recognised, viz., that afforded by the chloro- and bromo-naphthalenetetrachlorides, which has been discussed by Hintze (*Pogg. Ann.*, 1874, 6, 177). The author has examined the compounds referred to in the previous note, and finds the following crystallographic constants.

Substance.	System.	Geometrical constants.
1 : 2-Nitronaphthol	Monosymmetric	$a : b : c$ 1·5755 : 1 : 1·1938 $\beta = 161^\circ 26'$
1 : 2-Nitrethoxynaphthalene	Orthorhombic	2·4897 : 1 : 1·1606
1 : 2-Nitromethoxynaphthalene	Anorthic	0·9382 : 1 : 1·2088 $\alpha = 97^\circ 45'$, $\beta = 92^\circ 8'$, $\gamma = 88^\circ 27\frac{1}{2}'$
1 : 2-Nitrobenzyl naphthol (Sayer)	Orthorhombic	0·4892 : 1 : 1·0532
1 : 2-Acetamidomethoxynaphthalene ...	Monosymmetric	0·7999 : 1 : 0·7611 $\beta = 99^\circ 21'$
1 : 3' : 2-Nitrobromethoxynaphthalene .	Anorthic	1·4274 : 1 : 1·0265 $\alpha = 95^\circ 0'$, $\beta = 109^\circ 18'$, $\gamma = 80^\circ 15'$
1 : 3' : 2-Dinitromethoxynaphthalene ...	Orthorhombic	? : 1 : 1·1526

The crystallographic data thus obtained afford a series presenting the following salient points :

(1) In the transitions from 1 : 2-nitronaphthol to its methyl, ethyl and benzyl ethers, although marked changes of symmetry occur, the axial ratio $c : b$ remains nearly constant. In the passage from nitro- β -naphthol (monosymmetric) to its methyl ether (anorthic), there is a degradation of symmetry; but an increase in symmetry occurs in passing from 1 : 2-nitronaphthol to its ethyl ether (orthorhombic). These changes of symmetry are analogous to those which occur in the benzene series in passing from acetanilide to methyl and ethyl acetanilide respectively, only in the latter cases the changes are not

brought into evidence by changes of system, but only by corresponding changes in the axial ratios.

(2) When 1 : 2-nitrethoxynaphthalene (orthorhombic) is changed by the introduction of a bromine atom into position 3', a degradation to anorthic symmetry takes place, the axial ratio $c : b$ remaining, however, nearly unaffected.

(3) A remarkable increase of symmetry occurs when 1 : 2-nitromethoxynaphthalene (anorthic) is converted into the 1 : 3' : 2 dinitromethylether (orthorhombic), whilst the ratio of the c and b axes remains nearly constant; this increase of symmetry accompanying the introduction of successive units of the same radicle is comparable with the change in symmetry that occurs in the benzene series in passing from paranitrophenol (monosymmetric) to dinitro- and trinitro-phenol, both of which are orthorhombic, the symmetry in the case of the trinitro-compound tending towards that of the tetragonal system. When the various nitro-derivatives are melted on a microscope slide, and the solidified films are examined between crossed nicols, in the manner recently suggested by Mr. Pope (Proc. 1896, 12, 142) the appearances they present are very characteristic, as the photographs which are exhibited show; and an important proof is thus given of the use to which such a method can be put either in identifying isomeric substances occurring together—particularly if these melt at nearly the same temperature and are, therefore, liable to be confused with one another—or in recognizing the occurrence of a change from one crystalline modification to another.

***162. "Researches on tertiary benzenoid amines." II. By Clare de Brereton Evans, B.Sc.**

In continuation of the experiments referred to in a previous abstract (*cf.* Proc., 1896, 12, 235), the behaviour of diethylaniline, as well as that of dimethylortho- and dimethylpara-toluidine, has been further studied, and the series of isomeric dimethylanilinesulphonic acids has been completed by the preparation of the ortho-compound. For purposes of comparison, methyl- and ethyl-aniline have also been subjected to sulphonation.

Dimethylanilineorthosulphonic acid was prepared by methylating parabromanilineorthosulphonic acid and subsequently reducing the product.

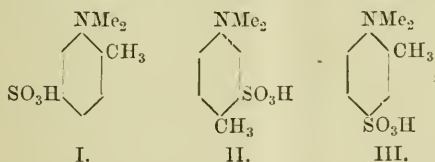
The constitution of the acids derived from the toluidines was determined by methylating the sulphonic acids of toluidine of known constitution.

Summarising the facts, the striking conclusion has been established that whereas orthosulphonic acids are readily obtained from

aniline derivatives—for example, parabromaniline, meta-acids only are formed from dimethyl- and diethyl-aniline and dimethylpara-toluidine: there being, apparently, an extraordinary “aversion” on the part of the sulphonic radicle to take up the ortho-position relatively to the NR'_2 group.

A similar inhibiting influence appears to be exercised by the group in preventing the entry of more than one bromine atom into the ortho-position. Such being the case, it is the more remarkable that when the sulpho-group does become displaced bromination extends much further in the case of the tertiary amines: dimethylaniline-para- and ortho-sulphonic acids being converted into *tetrabromodimethylaniline* and diethylanilineparasulphonic acid even into *pentabromodimethylaniline*; 1 : 2 : 5-dimethylorthotoluidinemetasulphonic acid in like manner yields *tetrabromodimethylorthotoluidine*. Sulphanilic acid, it is well known, yields only *tribromaniline*.

In the case of the acids derived from the dimethyltoluidines, viz.,



of which No. III was prepared by methylating the toluidinesulphonic acid, only the first yields a perbromide.

It is noteworthy that the sulphochlorides of the various acids are all hydrolysed with somewhat unusual readiness.

Methyl- and ethyl-aniline are found to behave exactly as aniline, so that the presence of hydrogen in association with the nitrogen atom would appear to play a part in the formation of orthamido-derivatives.

It is proposed to extend the experiments to the dimethylxylydines and cumidines.

163. “On the circumstances which affect the ratio of solution of zinc in dilute acids, with especial reference to the influence of dissolved metallic salts.” By John Ball, A.R.S.M.

The author considers the effects on the rate of solution of zinc in dilute acids of (i) variations of concentration of the acid; (ii) previous special treatment of the acid; (iii) variations of temperature; (iv) variations of pressure; (v) variations of the surface condition of the zinc; (vi) alloys of known amounts of foreign metals with the zinc; (vii) performance of the solution in vessels of different materials; (viii) addition to the acid solution of (a) oxidising agents; (b) reducing agents; (c) foreign acids; (d) salts of foreign metals.

The main portion of the paper deals with the effects produced by the presence of salts of various metals in the solution. Two main series of quantitative experiments for the comparison of the relative effects of salts of the different metals are described: one in solutions of sulphuric acid with magnesium, aluminium, chromium, manganese, iron, silver, copper, cobalt, or nickel sulphates as added salts; and one in solutions of hydrochloric acid, with manganese, lead, tin, copper, cobalt, gold, platinum, or nickel chlorides added. There is also a separate set of experiments in sulphuric acid solutions, with cobalt sulphate as added salt, in order to determine quantitatively the influence of the amount of salt used.

The metal used was pure distilled zinc, specially cast in very thin sheet. The results show that, both with sulphuric and hydrochloric acids, the addition of the foreign salts always accelerates the reaction, except in the case of magnesium and aluminium salts, which seem to be nearly without influence. The accelerating effect is most felt at the beginning of the reaction, and the velocity soon reaches a maximum (higher than that which would hold if no salt were present), which is practically constant nearly to the end. The acceleration is shown to be governed by a number of causes, of which the amount of metal precipitated from the added salt on the zinc is only a subordinate one, as the acceleration is often very great in cases where no precipitation can be determined—*e.g.*, 0.020 gram of nickel as sulphate added to a mixture of 17 c.c. of water, with 8 c.c. of sulphuric acid, at a temperature of 40°, increased the maximum velocity of reaction with zinc 37.87 times. In these cases a very minute trace of the added salt exerts an enormous influence, and, as shown by the experiments with cobalt sulphate, the effect of adding more of the salt becomes less perceptible as the total amount is increased, and ultimately we reach a point where further addition is without influence.

164. "The oxidation of ferrous sulphate by sea-water, and on the detection of gold in sea-water." By E. Sonstadt.

The experiments now described were made in the autumn of 1895, on sea-water supplied by the Great Eastern Railway Company in oak kegs, freshly filled, the water being stored in glass bottles as soon as received, and filtered before use.

I. *On the Oxidation of Ferrous Sulphate by Sea-water.*—In 1872 (*Chem. News*, 25, 196, 231, and 241), the author gave a description of experiments proving the existence in sea-water of calcium iodate, four parts of this salt being shown to be present in one million parts of sea-water. As these experiments have not, within my knowledge, been repeated, and as I do not know of any analysis of sea-water

recognising the presence of any salt therein capable of acting as an oxidiser, it seemed desirable to make direct experiment on the oxidising power of sea-water. To do this satisfactorily, it seemed necessary to compare sea-water against sea-water so treated as to reduce any salts of the nature of iodates that it might contain, due care being taken to thoroughly aerate the treated portion.

First Experiment.— $1\frac{1}{2}$ lbs. sea-water were evaporated to dryness with a small quantity (about 2 grams) of pure mercury, and the residue was heated in a porcelain crucible into which a current of hydrogen was passed, until the mercury was completely expelled. The salts were digested in water, and the solution made up by washings to the original quantity. The solution was then put into a Winchester quart bottle, and repeatedly shaken up, the air being renewed from time to time. When it was judged that the aeration was complete, one pint of the solution was put into a bottle which it nearly filled, and 1 gram of crystallised ferrous sulphate was added. A pint of the original sea-water was put into another similar bottle, with the same quantity of ferrous sulphate, and $1\frac{1}{2}$ c.c. of dilute hydrochloric acid was added to each solution. The bottles were corked, and after sufficient shaking to ensure mixture, were set side by side for three days, when the contents of both bottles were filtered simultaneously. After washing the precipitates with equal quantities of water, drying, and ignition, the ferric oxide from the natural sea-water weighed 0.0182 gram, and that from the treated sea-water, 0.0132 gram.

Second Experiment.—This was conducted similarly to the first experiment, except that instead of evaporating the sea-water with mercury, the latter was rubbed up with the residue left after drying. the subsequent heating in a current of hydrogen being conducted as before. Also, no acid was added to either the natural or the treated sea-water, and after the addition of ferrous sulphate, the solutions were allowed to stand in the corked bottles for 13 days before filtering. The natural sea-water gave ferric oxide 0.0540 gram (after solution and reprecipitation 0.0528 gram), and the treated sea-water 0.0270 gram. Thus, the difference in this case, when no acid was added, and more time was allowed for the formation of the precipitates, was very much more than in the first experiment, and is greatly in excess of what can be due to the influence of the iodate present in the untreated sea-water.

Although in these experiments it was found impossible to completely dissolve the salts obtained after ignition, in the quantity of water required to form an equal volume with the original sea-water taken, yet there is no reasonable ground for supposing that the change in composition thus effected could sensibly affect the oxidising

power, apart from the reduction involved of the iodate, and other salts at present unrecognised, of a reducible character. The insoluble residue contained traces of several metals, all of which were not definitely recognised, an account of which I defer until an opportunity occurs to me of working upon larger quantities of material.

II. *On the Detection of Gold in Sea-Water by means of Mercury.*—About 20 grams of pure mercury was agitated in a flask with about half a gallon of sea-water for a long while, the flask being placed at intervals on a water bath, so that the liquid became warm, though not hot. In subsequent experiments the water was not warmed, and no special proportion of mercury was used, though obviously, the smaller the proportion of mercury, the more agitation would be necessary to obtain the same result. The mercury was separated, washed, and dried with bibulous paper. The mercury was then volatilised in a porcelain crucible having an uninjured internal surface. A black, adherent film remained, fixed at a red heat. When the crucible had cooled, a small quantity of strong hydrochloric acid was added, which, on warming, dissolved the greater part of the film, leaving, however, a stain not removable by repeated similar treatments. The acid solution being washed away, and the crucible dried, a drop or two of aqua regia was let fall on the stain, which was almost immediately dissolved. By cupellation, a very minute gold bead was obtained. In some experiments, the mercury that had been agitated with sea-water was distilled in a current of hydrogen, but on afterwards heating the black residue in the porcelain boat in the open air, the residue was not adherent, and could not therefore be treated as described. To obtain an adherent film, 4 to 5 grams of mercury must be left for volatilisation in the open. The mercury that is distilled off in a current of hydrogen is quite pure; but that volatilised in contact with air is not pure; for if a portion of it be condensed on a cool surface, and then volatilised, a residue remains which disappears on strong heating. Silver is one of the metals dissolved out from the black residue by the hydrochloric acid with which it is treated. This fact, although somewhat outside the subject of the present paper, is worth mentioning, as having a bearing upon the question as to the condition in which the precious metals are present in sea-water. Mercury does not decompose silver chloride, either in the wet or dry way; and yet it separates silver from sea-water. The most natural inference appears to be that the silver salt in sea-water is so far attenuated by dilution as to have undergone molecular disruption, so that it may be considered to be present as metallic silver in solution. If this be so in respect to silver, the gold in sea-water is probably also in a similar condition.

A comparison cannot be instituted between the simple and easy process now described, for detecting the presence of gold in sea-water, and the processes given in the author's paper "On the Presence of Gold in Sea-water" in 1872 (*Chem. News.*, **26**, 159), because the sea-water that comes in kegs from the sea-side is very much poorer in gold than the water of the Irish Sea, on which the author's earlier experiments were made. When some gallons of sea-water, furnished by the Great Eastern Railway Company, were heated with ferrous sulphate and a little hydrochloric acid, and the precipitate, after a few days, collected, the minute gold bead from this precipitate (which was lost by accident before it could be weighed) was certainly but a small fraction of what the same quantity of sea-water previously experimented upon would have yielded. Whether this poverty in gold of the keg-water is due to its brief contact with wood, or to the circumstance that it is taken from shallow water near the shore, where a certain admixture with mud or clay is inevitable, may be doubtful. But it is probable that finely divided clay, mixed with sea-water, would carry down with it, in settling, most of the gold present.

ADDITIONS TO THE LIBRARY.

I. By Purchase.

Blyth, A. Wynter. *Foods: Their Composition and Analysis.* A manual for the use of analytical chemists and others. With an Introductory Essay on the history of adulteration. Fourth edition, revised and enlarged. xxxii+735 pp. London 1896.

Dammer, O. *Handbuch der Anorganischen Chemie.* Bde. I, II, 1, II, 2, and III. 1892-1894. Stuttgart. Circulating copy.

Gautier, Armand. *Les Toxines microbiennes et animales.* Avec 20 figures dans le texte. vii+617 pp. 8vo. Paris 1896.

Léger, E. *Les Alcaloïdes des Quinquinas* Avec une Preface de M. E. Jungfleisch. viii+278 pp. 8vo. Paris 1896.

Lorenz, Hans. *Neuere Kühlmaschinen, ihre Konstruktion, Wirkungsweise und industrielle Verwendung.* viii+219 pp. München 1896.

Meyer, Arthnr. *Untersuchungen über die Stärkekörner.* Wesen u. Lebensgeschichte der Stärkekörner der höheren Pflanzen. Mit 9 Tafeln u. 99 in den Text gedruckten Abbildungen. xvi+318 pp. Jena 1895.

Minerva. *Jahrbuch der gelehrten Welt.* Sechster Jahrgang. 1896-1897. xxiv+1082 pp. Strassburg 1897.

Rosenbusch, H. Mikroskopische Physiographie der Mineralien und Gesteine. Band II. xiv+1360 pp. Stuttgart 1896.

Schnabel, Carl. Handbuch der Metallhüttenkunde. Zweiter Band. Zink, Cadmium, Quecksilber, &c. xii+760 pp. Berlin 1896.

Schultz, Gustav, und Julius, Paul. Tabellarische Uebersicht der im Handel befindlichen künstlichen organischen Farbstoffe. Dritte vollständig umgearbeitete und stark vermehrte Auflage. xvi+216 pp. Berlin 1897.

II. *Donations.*

The Edinburgh Philosophical Journal. Vols. 1—10. 1819—1824.

From Professor W. R. Dunstan, F.R.S.

Jahresbericht über die Fortschritte der Chemie und verwandter Theile anderer Wissenschaften. I & II Heft. 1886.

From Professor W. R. Dunstan, F.R.S.

Harcourt, A. G. Vernon, and Madan, H. G. Exercises in Practical Chemistry. Fifth edition revised by H. G. Madan, M.A., F.C.S. xvi+598 pp. Oxford 1897.

From H. G. Madan, Esq.

Watt, George. A Dictionary of the Economic Products of India. Index. 165 pp. Calcutta 1896.

From the Government of India.

Pamphlet.

Jowett, H. A. D. On Atisine, the Alkaloid of Aconitum Heterophyllum. 30 pp. London 1896.

From the Author.

At the next meeting, Thursday, December 17, the following papers will be received:—

“On the experimental methods employed in the examination of the products of starch hydrolysis.” By Horace T. Brown, F.R.S., G. H. Morris, Ph.D., and W. H. Millar.

“On the specific rotation of maltose and of soluble starch.” By Horace T. Brown, F.R.S., G. H. Morris, Ph.D., and W. H. Millar.

“On the relation of the specific rotatory and cupric reducing powers of the products of starch hydrolysis by diastase. By Horace T. Brown, F.R.S., G. H. Morris, Ph.D., and W. H. Millar.

“Percarbonate of Cobalt.” By R. G. Durrant.

PROCEEDINGS
OF THE
CHEMICAL SOCIETY.
EDITED BY THE SECRETARIES.

No. 172.

Session 1896-97.

Dec. 17th, 1896. Mr. A. G. Vernon Harcourt, President, in the Chair.

Messrs. Alexander Scott, Frederick B. Power, W. W. Cobb, and Claude M. Thompson were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. Alfred Cartmell, Alexandra Road, Burton-on-Trent; William Diamond, Pye Bridge, Alfreton; William Buckland Edwards, 5, Garlinge Road, Brondesbury, N.W.; Vaughan Harley, M.D., 25, Harley Street, W.; Fred Ibbotson, B.Sc., 9, Melbourn Road, Spring Vale, Sheffield; David Smiles Jerdan, M.A., B.Sc., 68, Union Street, Greenock; Edward Rosling, Melbourne, Chelmsford; Henry Potter Stevens, B.A., 14, Lower Sloane Street, Chelsea, S.W.; Harry Thompson, Walton House, West Parade, Anlaby Road, Hull.

The certificate of the following candidate, recommended by the Council, under Bye-law I, par. 3, was also read:—

Jyoti Bhusan Bhaduri, Presidency College, Calcutta.

Of the following papers those marked * were read.

- *165. "On the experimental methods employed in the examination of the products of starch-hydrolysis by diastase." By Horace T. Brown, F.R.S., G. Harris Morris, Ph.D., and J. H. Millar.

The paper is divided into the following sections: (1) the determination of solids from solution-density; (2) determination of specific rotatory power; (3) the relation of $[\alpha]_J$ to $[\alpha]_D$; (4) determination of cupric reducing power; (5) limits of accuracy of the methods.

The authors state that this account is a preface to a series of papers dealing with the question of starch-hydrolysis, and is a critical review of the experimental methods which have been employed by different observers who have approached this subject. An attempt has also been made to remove the misunderstanding which still exists as to the relations of the different systems of notation.

The determination of the total solids from the density of the solution by the employment of the "divisor" method admits of great accuracy if the solution-densities of the pure substance have been previously determined.

The "divisors" at varying concentration have been determined for cane sugar, maltose, dextrose, levulose, soluble starch, and the mixed products of starch-hydrolysis of various grades, and the results have been plotted out in the form of curves whose equation is given in each case. The pure substances used in constructing these curves were dried in a vacuum over phosphoric pentoxide at temperatures from 100° to 130° .

For mixed starch hydrolytic products, the divisor for equal concentrations increases with the specific rotatory power, and in such a regular manner that when the value of R is known, the divisor at any given concentration can be calculated. From the relation which this divisor bears to the divisor of the apparent maltose present in the mixed hydrolytic products, it is deducible that the divisor for the amylin constituent is constant for equal concentrations, even in starch products of very different grades of hydrolysis.

In the section on specific rotatory power, the methods of exact determination are discussed, and the relations of $[\alpha]_J$, $[\alpha]_{J3.56}$, and $[\alpha]_D$ are defined for substances of equal dispersive power. As the dispersive power of cane sugar is sensibly different from that of dextrose and starch-hydrolytic products obtained by diastase, the factors for the conversion of $[\alpha]_J$ into $[\alpha]_D$ are not identical in these cases. Much confusion of these relations has also been introduced by the unrecognised fact that $[\alpha]_J$ has been referred to two distinct rays in the yellow of different refrangibility.

The cupric-reduction of maltose and of the products of starch-transformation is constant only when the conditions of experiment are identical. These are exactly defined for the authors' method of procedure, and the reducing values are given in tabular form, and are compared with those of other observers.

*166. "On the specific rotation of maltose and of soluble starch." By Horace T. Brown, F.R.S., G. Harris Morris, Ph.D., and J. H. Millar.

The authors' determinations of the specific rotatory power of maltose at a temperature of 15.5° do not confirm the statement of

Meissl that the values of $[\alpha]_D$ vary with the concentrations between 2 and 20 per cent., but confirm the general statement of Ost that between these limits the specific rotatory power is constant. At higher concentrations than 20 per cent., the specific rotatory power diminishes slightly.

The actual results point to a value of $[\alpha]_D = 137.93^\circ$, which is sensibly greater than Ost's value of 137.46° at 15.5° .

This discrepancy is due to the fact that Ost employed weighed quantities of hydrated maltose which had been dried in a desiccator over sulphuric acid. The authors find that even after six weeks' drying in this manner, hydrated maltose contains 0.46 per cent. more water than corresponds to $C_{12}H_{22}O_{11} \cdot H_2O$. If Ost's numbers are corrected for this they give values, up to 20 per cent. concentrations, of $[\alpha]_D = 138.12^\circ$ at 15.5° , a result almost exactly identical with that of the authors.

The specific rotatory power of soluble starch for concentrations of 2.5 to 4.5 per cent. is, at 15.5° , $[\alpha]_D = 202.0^\circ$.

*167. "On the relation of the specific rotatory and cupric-reducing powers of the products of starch-hydrolysis by diastase." By Horace T. Brown, F.R.S., G. Harris Morris, Ph.D., and J. H. Millar.

When starch is transformed by diastase, a certain relation is always found to subsist between the cupric-reduction and specific rotatory power of the hydrolytic products. This relation can be expressed in such a manner as to be entirely independent of any view we may hold as to the true nature of the transformation products, and it is of so exact a nature that if one property is known the other can be predicted with certainty. This is true not only for the mixed hydrolytic products, but for any fractionated portion of them.

The authors regard this fact as lying at the root of the whole question of starch-hydrolysis, and, as it is still not admitted by most continental workers, they bring forward a large amount of fresh evidence which they regard as absolutely conclusive.

The results of the examination of 70 different starch transformations are given, some of them mixed products, others fractionated products, the specific rotatory and cupric-reducing powers being given in the various notations in use. When the experimental results are plotted on a system of rectangular co-ordinates, the degrees of specific rotation between soluble starch and maltose being represented on the line of ordinates, and the cupric-reducing powers from soluble starch to maltose on the line of abscissæ, the values all fall practically on a straight line joining the points of intersection of the co-ordinates corresponding to the optical and reducing properties of soluble starch and of maltose respectively.

The properties of soluble starch being $R = 0$, $[\alpha]_D = 202^\circ$, and of maltose, $R = 100$ and $[\alpha]_D = 138.0^\circ$, then the relation of specific rotation and cupric reduction for any mixture or fractionation of the starch-hydrolytic products will be expressed by $[\alpha]_D = 202 - 0.64 R$.

The differences in the calculated and observed values for the 70 cases of hydrolysis examined are given, and are shown to be very small indeed.

The authors have examined the published results of C. J. Lintner and of Ost, both of whom have denied the existence of any relation between $[\alpha]_D$ and R , and find that, when rightly interpreted, they, for the most part, strictly conform to the law of relation expressed above.

DISCUSSION.

Dr. ARMSTRONG, after commenting on the value of the information brought under the notice of the Society by Mr. Horace Brown and his co-workers, and on the remarkable accuracy with which starch could now be estimated, expressed the hope that it would be possible ere long to determine what really took place when starch was hydrolysed; he thought it was time that we should no longer be content merely to determine certain analytical factors; we ought rather to seek for chemical methods which would render it possible to separate and isolate the products.

Mr. A. R. LING asked what value the authors found for the cupric reducing power of maltose when Wein's method was used.

Dr. G. H. MORRIS, in reply, said that they found that Wein's tables give results about 5 per cent. too low when the cupric reduction of maltose is estimated by Wein's method, and the copper obtained calculated into maltose by the table; in other words, perfectly pure maltose gives $R = 95-96$ instead of 100.

*168. "The action of hydrogen peroxide and other oxidising agents on cobaltous salts in presence of alkali bicarbonates." By R. G. Durrant, M.A.

Similar green solutions may be obtained by adding hydrogen peroxide, sodium hypochlorite, chlorine, bromine, or ozone to cobaltous salts in presence of alkali bicarbonates—or by adding a cobaltous salt to the anode of previously electrolysed potassium carbonate.

The green colour is not destroyed by excess of cold acetic acid, but is rendered rather bluer in tint. This acetic solution is reduced by hydrogen peroxide.

The evidence so far obtained shows (1) that the cobalt is in the "cobaltic state." This is proved by the results of three

volumetric methods—in which standard sodium hypochlorite, hydrogen peroxide, and sodium sulphite are respectively employed—green precipitates, produced from the green solutions, gave results showing that the available oxygen closely approximates to that to be expected from cobaltic hydrate.

- (2) That the green colour of the solutions and of the precipitates appears not to be due to a particular alkali, since (i) identical tints were obtained with the five different alkali bicarbonates, (ii) potassio-cobaltic nitrite gives no green colour with bicarbonates, (iii) green precipitates washed free from all alkali, and digested with cold weak acetic acid give green filtrates.
- (3) That carbon dioxide is necessary both for the formation and preservation of the green colour. The green colour of the acetic solution remains only so long as carbon dioxide is present. The green precipitates (free from alkali) retain carbon dioxide so long as they remain green, and lose it when they become brown. It is, therefore, possible that the green cobaltic compound is of the nature of a carbonate.

DISCUSSION.

Several speakers, including the PRESIDENT, expressed the view that whilst the author had made it clear that the green substance was a cobaltic compound, further proof was needed of the suggestion that the salt formed was a cobaltic carbonate.

Dr. RIDEAL mentioned that sodium peroxide, as well as hydrogen peroxide, gave rise to the green colour, provided that an alkali bicarbonatate was also present.

Dr. ARMSTRONG said that he would like to give expression to the opinion that the time was come to determine what should be their course of action with regard to the publication of the discussions that took place at the meetings; of late there had been an almost entire absence from the Proceedings of reports of the remarks made in the room, although these had often been of a nature which made it desirable that they should be brought under the notice of the Fellows generally. If the Secretaries could not undertake the work, steps should be taken to procure a proper report. Personally he had had no difficulty in obtaining reports during the nine years in which he had charge of the Proceedings, and he did not believe that there would be any difficulty. Without such reports the Proceedings were of little value.

Professor DUNSTAN said that Fellows attending the meetings were aware that it was not often that a comprehensive discussion followed

the reading of an ordinary paper. All important remarks and suggestions made at the meetings had been recorded in the Proceedings, and although no attempt had been made to record everything, and there might occasionally be room for difference of opinion as to what was important, he was always glad to receive from speakers, after the meeting, reports of their remarks, which he believed had been in nearly every case inserted in the Proceedings. He had, however, not thought it desirable to print Dr. Armstrong's remarks, of the omission of which Dr. Armstrong now complained, made on two recent occasions proposing to record the time occupied by readers of papers. The method adopted by the speaker's predecessor in office in reporting discussions had given rise to much dissatisfaction. If the present plan was not thought sufficient, then a shorthand report of the discussions could be taken. As a matter of fact, however, the main value of the Proceedings lies in its being the means of bringing at an early date under the notice of the Fellows, not merely remarks and suggestions made at the meetings, but concise abstracts of the papers read, the full publication of which could not take place in the Journal until much later.

The PRESIDENT remarked that if a full report of the proceedings were considered desirable, its preparation could not be included in the duties of the Honorary Secretaries. He was disposed to think, however, that if it were generally known that the Secretaries were ready to receive from speakers after the meeting a few sentences giving the substance of their remarks, that this would meet the case in nearly every instance.

169. "Electrical conductivity of diethylammonium chloride in aqueous alcohol." By James Walker, Ph.D., D.Sc., and F. J. Hambly, F.I.C.

The authors have determined the conductivity of diethylammonium chloride dissolved in pure water, and in 10.1, 30.7, 49.2, 72.0, 90.3, and 99.0 per cent. alcohol, by volume, at dilutions ranging from 10 litres to 8000 litres. Tables and curves have been constructed, showing the variation of the molecular conductivity and the degree of dissociation with varying dilution and varying proportions of alcohol.

170. "Formation of substituted oxytriazoles from phenylsemicarbazide." By George Young, Ph.D., and Henry Annable.

The action which takes place when a mixture of phenylsemicarbazide and benzaldehyde is oxidised, has been reinvestigated, and the views expressed by one of the authors in a previous paper (Trans., 1895, 67, 1063) have been confirmed. The following aldehydes yield

oxytriazoles by this action: metanitrobenzaldehyde, paranitrobenzaldehyde, metatoluic aldehyde, terephthalic aldehyde, cinnamic aldehyde.

The authors have failed to obtain oxytriazoles from formaldehyde, acetaldehyde, paraldehyde, isobutyric aldehyde.

171. " α -Bromocamphorsulpholactone." By C. Revis and F. Stanley Kipping, Ph.D., D.Sc.

When α -bromocamphor is treated with anhydrosulphuric acid, or with chlorosulphonic acid, it is converted into α -bromocamphorsulphonic acid (Trans., 1893, **63**, 548). In the course of some experiments on the preparation of this sulphonic acid, it was found that when 70 per cent. anhydrosulphuric acid is added to a solution of α -bromocamphor in chloroform, the product consists, to some extent, of a crystalline compound which is insoluble in water.

This substance has the composition $C_{10}H_{13}BrSO_4$ (found C = 38.8, H = 4.3, Br = 25.1, S = 9.7 per cent.; calculated C = 39.0, H = 4.2, Br = 25.8, S = 10.3 per cent.). It appears to be a bromocamphorsulpholactone, and its formation is doubtless due to the oxidation of hydrogen to hydroxyl accompanying sulphonation, water being then eliminated from the hydroxysulphonic acid; it is, probably, closely related to the dibromocamphorsulpholactone, $C_{10}H_{12}Br_2SO_4$, recently described (Lapworth and Kipping, Proc., 1896, **12**, 77), and it resembles the latter in ordinary properties. It crystallises from chloroform and ethylic acetate in lustrous, transparent plates or prisms, melts at about 290° , and is moderately easily soluble in boiling acetic acid, chloroform, and ethylic acetate. It is very stable, and separates, unchanged, from a solution in nitric acid (sp. gr. 1.4), even after heating for some time; it seems not to be attacked by cold potash (sp. gr. 1.3), and, even on boiling, it is only slowly dissolved.

Dr. Lapworth has, independently, observed the formation of this lactone from α -bromocamphor and anhydrosulphuric acid.

172. "Dimethylketoexamethylene." By F. Stanley Kipping, Ph.D., D.Sc.

In a recent paper on camphoric acid (*Amer. Chem. J.*, 1896, **18**, 685), Noyes describes the preparation, from dihydrocampholytic acid, of a ketone which forms an oxime melting at 112 — 113° , and possesses an odour similar to that of camphoroxime. On comparing the melting point of this oxime with that of the isomeric oxime of dimethylketoexamethylene, he found that, for the latter, the author had given the melting point 114 — 115° (Trans., 1895, **67**, 349), whereas Zelinsky had given it as 104 — 105° (*Ber.*, 1895, **28**, 781). Noyes

himself then prepared dimethylketohexamethylene oxime, and found the melting point to be 120—122°.

The possible identity of the two oximes in question being a matter of great importance—for, if their identity were established, much light would be thrown on the constitution of camphor—the author has prepared dimethylketohexamethylene by the improved method recently described (Kipping and Edwards, *Proc.*, 1896, **12**, 188), and has made further experiments with this substance.

The oxime, prepared in the usual manner, is at first very oily, apparently from the presence of unchanged ketone, but it soon becomes a semi-solid crystalline mass; when freed from oil and recrystallised once or twice, it melts quite sharply at about 114°, but further purification raises the melting point to 117·5° (uncorr.), at which point it remains, even after six successive crystallisations from different solvents. This melting point and that previously recorded were taken with an ordinary standard thermometer; observations made with a short thermometer, the thread of which was entirely immersed, gave a m. p. of 118·5—119°. Noyes does not state whether the m. p., 120—122°, is corrected, nor how the observation was made, and the range of 2° would seem to indicate that the substance did not melt sharply; he also leaves the identity of his dimethylketohexamethylene oxime with the oxime of the ketone which he obtained from camphor an open question.

Noyes suggests that the several preparations of the oxime obtained respectively by Zelinsky, by himself, and by the author, may be mixtures of stereoisomerides, and the latter has therefore directed attention to this possibility; there are certainly indications of the presence of more than one substance in the crude oxime, as a few crystals, melting not sharply at about 75°, have been separated; nevertheless, the only crystalline product which has yet been isolated in any quantity is that which melts sharply and constantly at 118·5—119° (corr.).

This oxime crystallises from a mixture of chloroform and light petroleum in lustrous, transparent prisms, which have been examined by Mr. Pope. "The crystals consist of monosymmetric prisms, which show the forms {100}, {001}, {110}, and {111}; the plane of symmetry is the optic axial plane, and an optic axis emerges normally to the face (100). Some faces give good reflections, but parallel faces do not give images at 180° to one another, a behaviour which is frequently observed in the case of mixtures." This indication that the oxime may be a mixture, in spite of its constant melting point, must be borne in mind, and if confirmed, the different melting points of the various preparations would be accounted for.

In order to facilitate the identification of dimethylketohexamethyl-

ene, the author has prepared the semicarbazone; this compound slowly separates in crystals on warming the ketone with a solution of semicarbazone hydrochloride and sodium acetate in dilute alcohol. After recrystallisation it melts at about 196° , and further treatment does not seem to change its melting point. A sample dried at 100° gave $C = 59.26$, $H = 9.36$ per cent.; calculated for $C_9H_{17}N_3O$, $C = 59.02$, $H = 9.29$ per cent.

Dimethylketohexamethylene semicarbazone is fairly soluble in cold chloroform but less so in cold benzene and ethylic acetate, and crystallises best from methyl alcohol in the form of small, translucent, well-defined prisms. Heated slowly from about 175° , and using a short thermometer, it begins to sinter at about 190° , and melts completely at about $200-201^{\circ}$, effervescing, but not darkening; the m. p. depends on the size of the crystals and on the rate of heating. The crude semicarbazone seemed to be homogeneous, and the yield appeared to be good, but as, on recrystallising the preparation from boiling acetic acid, most of it suffered decomposition, further experiments are necessary to prove that only one semicarbazone exists.

173. "The localisation of deliquescence in chloral hydrate crystals."
By William Jackson Pope.

Chloral hydrate crystallises from solution in large monosymmetric plates, showing the forms $\{100\}$, $\{011\}$, and $\{\bar{1}11\}$, and having the axial ratios $a : b : c = 1.6369 : 1 : 1.3951$, $\beta = 59^{\circ} 5'$; these crystals consist of the same modification of chloral hydrate as was obtained in previous experiments (Pope, Proc., 1896, 12, 142), and described as the biaxial modification, stable at ordinary temperatures. The crystals deliquesce in the air, but in a peculiar manner; the forms $\{011\}$ and $\{\bar{1}11\}$ rapidly absorb water vapour, and after a few minutes' exposure become covered with a layer of solution, whilst the faces of the form $\{100\}$ remain perfectly bright during a considerable time. The attraction for moisture exercised by the pinacoid $\{100\}$ is thus much less than that exhibited by the other two forms.

It is consequently concluded that crystal deliquescence, like crystal solubility and other properties, varies with the direction in the crystal perpendicular to which its intensity is measured.

174. "Enantiomorphism." By William Jackson Pope and Frederic Stanley Kipping.

Crystals of the two enantiomorphous forms of a substance which exhibits circular polarisation only in the crystalline state, and in which the circular polarisation is an inherent property of the crystal structure, *i.e.*, of a substance belonging to Class 2b (Pope, Trans.,

1896, 69, 971), should be deposited from the optically inactive solution in equal numbers, unless any disturbing factor is operative favouring the deposition of crystals of one particular enantiomorphous form, as, for example, contact of the slightly supersaturated solution with a crystal of that form. The truth of this statement can be demonstrated from our present knowledge of crystal structure, and is also evident from a consideration of the recent work of Landolt (*Ber.*, 1896, 29, 2404), who showed that the crystalline powder of sodium chlorate, which rapidly separates from aqueous solution, consists of almost equal quantities of dextro- and lævo-rotatory crystals. The authors have extended these observations, and by taking a number of different crops of the large crystals deposited by spontaneous evaporation of sodium chlorate solution, have ascertained that the average numbers of dextro- and lævo-crystals deposited are the same, in absence of any disturbing factor.

It seemed probable that if a substance which is optically active in solution is introduced into an aqueous solution of sodium chlorate, the presence of the former would favour the deposition of chlorate crystals of one particular enantiomorph, and experiments were consequently made to test this view. About 5 per cent. of some substance, such as dextrose, mannitol, and isodulcitol, was dissolved in a saturated sodium chlorate solution, and the crystals of the salt deposited on spontaneous evaporation examined; a great preponderance of lævo-crystals separated from the dextrose solutions whilst in the separation from the isodulcitol solutions the dextro-crystals were in excess. The mannitol solutions deposited rather more lævo- than dextro-crystals; a number of crops from each solution were collected, and similar behaviour was noticed with each crop.

This selective deposition would seem to indicate, as would, indeed, be expected, from a consideration of the equilibria possible in such systems, that the solubility of a dextro-enantiomorph of Class 2*b* (see above) in a liquid containing an optically active substance, differs from the solubility of the lævo-enantiomorph in the same solvent. Solubility determinations, and also determinations of the rates of growth of dextro- and lævo-crystals of sodium chlorate in optically active solutions are in progress.

There would seem to be no *à priori* reason why a substance optically active in solution only and possessing a high specific rotation, should exert more directive influence on the deposition of crystals of Class 2*b* than an optically active substance of very low specific rotation, the only condition necessarily favouring the deposition of crystals of a particular enantiomorph being that there should be an asymmetric compound in solution. Using methods such as those indicated above, it might, therefore, be possible to determine with ease and rapid-

ity whether certain substances which, although containing asymmetric carbon atoms, are optically inactive in solution, are really asymmetric compounds, the inactivity in solution being due to a compensation brought about amongst the four different groups attached to one asymmetric atom. Experiments respecting this point are in progress.

Several cases, such as that of camphorsulphonic chloride (Kipping and Pope, *Trans.*, 1893, **63**, 560), are known in which equal quantities of optical antipodes, when crystallised together, apparently do not form a racemic compound. In the light of the foregoing results, it should be possible to effect a partial separation of such mixtures, and even of racemic compounds, by crystallising them from a solution containing an optically active substance. Experiments on the separation of a number of racemic compounds, and of inactive mixtures of optical antipodes by methods based on the above considerations, have been commenced, but the results are not yet sufficiently conclusive to warrant any definite statements respecting them.

Premising the truth of the considerations stated above, Eakle's observation (*Zeit. f. Kryst.*, 1896, **26**, 562) that a sodium periodate solution containing sodium nitrate deposits more lævo- than dextro-crystals of the periodate, is quite incomprehensible.

IMPORTANT NOTICE TO AUTHORS OF PAPERS.

The attention of authors is directed to the following resolution of the Council.

"No title shall be included in the list of titles of papers to be brought before a Meeting of the Society, unless the paper and an abstract of it are in the hands of the Secretaries at least three days before the date of the Meeting; and no announcement of titles can be made in the Proceedings until the papers have been received by the Secretaries."

RESEARCH FUND.

A meeting of the Research Fund Committee will be held in January. Applications for grants, accompanied by full particulars, should be sent to the Secretaries on January 15.

At the next meeting, on January 21st, the following papers will be received. The authors of those marked with an asterisk have announced their intention of being present:—

*“Studies of the properties of highly purified substances. I. The influence of moisture on the production of ozone from oxygen and on the stability of ozone. II. The behaviour of chlorine, bromine, and iodine with mercury. III. The behaviour of chlorine under the influence of the silent discharge of electricity, and in sunlight.” By W. A. Shenstone.

*“Action of diastase on starch.” Part III. By A. R. Ling and J. L. Baker.

*“The solution-density and cupric reducing power of dextrose, levulose, and invert-sugar. By Horace T. Brown, F.R.S., G. Harris Morris, Ph.D., and J. H. Millar.

“Derivatives of Maclurin.” Part II. By A. G. Perkin.

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Jan. 17, 1889		Barnes, Charles Lightfoot, 10, Nelson-st., Oxford-st., Manchester
May 7, 1891		Barnes, Edward Arthur, 194, Hammersmith-road, W.
Dec. 2, 1875		Barnes, R. L., Oak Hall, Buckhurst-hill, and c/o of W. E. Barnes & Co., Hackney Wick, N.E.
Feb. 21, 1884		Barr, William Henry, M.D., Belgrave-place, Bury
Feb. 16, 1888		Barraclough, William H., F.I.C., Harcourt-lodge, Chapeltown, near Sheffield
May 16, 1895		Barralet, E. S., 61, Thistlethwaite-road, Clapton, N.E.
Dec. 3, 1891		Barratt, J. Treeby, Bronhenlog, Mostyn, North Wales

Date of Election.

Feb. 4, 1869		Barret, Edward J., B.Sc., 11, Rue de l'Hotel de Ville, Neuilly, Paris
Feb. 5, 1874		Barrett, Howard, M.R.C.S., M.R.C.P., 49, Gordon-square, W.C.
June 16, 1892	Trans.	Barrows, Arthur Edward, Bloemfield Iron Works, Tipton, Staffordshire
Jan. 18, 1872		Barton, Robert, Royal Mint, Melbourne, Australia
April 19, 1883		Basker, J. A., Fore-street, Bridgwater
Feb. 18, 1864	Trans.	Bassett, Henry, 26, Belitha-villas, Barnsbury, N.
May 7, 1891		Bate, William, National Explosives Co., Hayle, Cornwall
June 15, 1893		Bateman, John, Messrs. J. C. and J. Field, The Marsh, Lambeth, S.E.
May 7, 1891		Bater, Claude H., M.A., Inland Revenue, Ashwell, Baldock, Herts
June 16, 1892		Bayliss, Charles, Selly Park, near Birmingham
Nov. 19, 1874		Bayly, F. W., The Royal Mint, E.
June 4, 1874		Bayne, James, Professor Royal Veterinary College, Camden Town, N.W.
June 19, 1879		Bayne, William Thirlwall, LL.D., Brockhill, Broad Clyst, Exeter
Dec. 4, 1873		Baynes, James, Ph.D., F.R.M.S., Borough Analyst's Office, Royal Chambers, Scale-lane, Hull
Feb. 19, 1891	Trans.	Beadle, Clayton, Beadonwell, Belvidere, Kent
Feb. 7, 1861		Beaduell, Major Charles Edward, R.A., 48, Castletown-road, W. Kensington
Dec. 5, 1867		Beale, William Phipson, Q.C., 10, New-court, Carey-street, Lincoln's-inn, W.C.; and 19, Upper Phillimore-gardens, Kensington, W.
Mar. 3, 1864		Beanes, Edward, 119, Ashley-gardens, S.W.
Mar. 6, 1890		Beardmore, G. Russell, D.P.H. Camb., L.R.C.P. Lond., M.R.C.S. Eng., L.S.A., Warwick House, Upper-street, Islington, N.
April 21, 1887		Beasley, William C. T., B.A., Fermain, St. Leonards-on-Sea
April 17, 1890	Trans.	Beck, Charles R., 15, Abbotsford-road, Redland, Bristol
April 2, 1874	Trans.	Beckett, George Henry, care of Alfred Nobel, Chemisches Laboratorium, San Remo, Italy
May 4, 1882		Beckett, John Hampden, Corbar Hill House, Buxton, Derbyshire
Feb. 6, 1879	Trans.	Bedson, P. Phillips, D.Sc., University of Durham, College of Physical Science, Newcastle-on-Tyne
Dec. 19, 1872	Trans.	Beilby, George T., St. Kitts, Slateford, N.B.
June 18, 1891		Belbin, T. St. J., 101, Piccadilly, W.
Dec. 6, 1888		Belcher, John Hope, B.A., Science School, Lincoln
May 7, 1891		Bell, Albert Edward, F.I.C., 2, Ellington-villas, Sherborne, Dorset
Dec. 2, 1886	Trans.	Bell, Chichester A., B.A., M.B. (Dublin), 3, Mansfield-place, Richmond, Surrey
June 20, 1889		Bell, E. Wightman, Spalding

Date of Election.		
Jan. 19, 1865		Bell, J. Carter, the Cliff, Higher Broughton, Manchester
Dec. 3, 1863	Trans.	Bell, Sir Lowthian, Bart., F.R.S., Rounton Grange, Northallerton
Jan. 17, 1889		Bell, Percy Carter
Dec. 4, 1879		Bemrose, Joseph, 56, St. Famille street, Montreal, Canada
Dec. 17, 1874		Bendix, David, Sutherland Lodge, 371, Romford-road, Statford, E.
Nov. 19, 1874		Benger, Frederick Baden, F.I.C., The Grange, Knutsford, Cheshire
Feb. 17, 1881		Benjamin, Marcus, A.M., Ph.D., Smithsonian Institute, Washington, D.C.
April 15, 1836		Bennert, Carl, Ph.D., Godesberg, Germany
Feb. 20, 1896	Trans.	Bentley, W. H., B.Sc., 110, Yarburgh street, Moss Side, Manchester
Dec. 4, 1890		Bentz, Ernest, 5, Demesne-road, Whalley Range, Manchester.
June 21, 1883		Beringer, Cornelius, Falmouth-road, Redruth
Feb. 16, 1882		Beringer, John J., Basset-road, Camborne, Cornwall
Dec. 5, 1895		Berkeley, The Earl of, Foscombe, Boar's Hill, near Abingdon
Mar. 6, 1890		Berncastle, Richard, 22, Aldridge-road Villas, Bayswater, W.
June 15, 1893		Berridge, Douglas J. P., B.A. Oxon, The Laboratory, Malvern College
Feb. 16, 1888		Berridge, Henry Dudley, M.A., Fotheringhay, Oundle, Northamptonshire
Dec. 7, 1882		Berry, Edward E., Villa Rosa, Bordighera, Italy
Dec. 3, 1891		Berry, Thomas William, Granville terrace, Stone, Staffordshire
Dec. 6, 1888		Berry, William, 7, Hampton-park, Redland, Bristol
Dec. 15, 1892		Bersusan, Arthur J., 13, Lansdowne-road, Kensington-park, W., and Box 411, G.P.O., Sydney, N.S.W.
Mar. 1, 1883	Trans.	Bevan, Edward J., 4, New-court, Lincoln's-inn, W.C.
Dec. 2, 1886		Bevan, John William, care of Sir James Murray and Co., Chemical Works, Temple-street, Dublin
Dec. 7, 1865		Bickerdike, W. E., Bryer's Grove, Wilpshire, near Blackburn
Feb. 18, 1875		Biggart, J. W., Chemical Laboratory, 29, Cathcart-street, Greenock
Mar. 7, 1872		Biggs, C. H. W., 140, Salisbury-court, Fleet-street. E.C., and Broomfield, Bromley, Kent
Dec. 15, 1881		Bingley, John, Northampton
June 4, 1874		Bird, Henry, South Down House, Millbrook, near Plymouth
Feb. 15, 1894		Bird, William Rowland, 12, Gordon-road, New Swinden, Wilts
May 20, 1875	Trans.	Bischof, Gustav, Prof., 4, Hart-street, Bloomsbury
April 17, 1879		Black, A. H., F.R.G.S., St. John's, Wakefield
Dec. 3, 1886		Blackburn, Thomas, Aruba Phosphaat Maatschappy, Curaçoa, West Indies
Dec. 18, 1879		Blackett, Cuthbert R. Laboratory, Swanston-street, Old County Court, Melbourne

Date of Election.

March 5, 1885		Blades, Chas. Mountain, Bay Villa, Chester-road, Northwich, Cheshire
Dec. 6, 1883		Blair, Frank A., Broomfield, Melrose, N.B.
Mar. 6, 1890		Blake, Robert R. F., Chemical Department, Queen's College, Belfast
May 15, 1890		Blake, William Henry, Clendon Tower, near Sunderland
June 3, 1875		Blanshard, Charles Thomas, M.A., F.I.C., The Firs, Summertown, Oxford
June 16, 1892		Bleckly, Arthur Sanderson, Thelwall Lea, near Warrington
Dec. 4, 1890		Blenkinsop, W. E. B., 15, Earlsfield-road, Wandsworth Common, S.W.
Feb. 20, 1896		Blood, M., B.A., 3, Stanley-terrace, Clifton-road, Norbiton
Feb. 19, 1891		Bloomer, Frederick John, F.I.C., 40, Summersfield-erescent, Rotton-park, Birmingham, and 15, Broderick-road, Upper Tooting
Ma 6, 1890	Trans.	Blount, Bertram, Laboratory, Broadway, Westminster, S.W.
Feb. 2, 1888		Bloxam, Arthur G., F.I.C., The Goldsmiths' Institute, New Cross, S.E.
Dec. 20, 1883	Trans.	Bloxam, W. Popplewell, B.Sc. Lond., F.I.C., Royal Naval College, Greenwich, S.E.
May 16, 1895		Blume, E., Russell House, Trinity, Edinburgh
Feb. 2, 1865	Trans.	Blunt, T. P., M.A., Tower-place, Shrewsbury
April 21, 1887		Blundstone, Edwin Richardson, B.A., Cornwall Lodge, Hampton Hill, Middlesex
Feb. 20, 1896		Blyde, J. E. A., Nether House, Raymoor, Sheffield
June 3, 1875	Trans.	Blyth, Alexander Wynter, M.R.C.S., 29, Norfolk-road, N.W.
May 5, 1892		Blyth, M. Wynter, B.A., B.Sc., 29, Norfolk-road, N.W.
Dec. 2, 1875		Boake, A., Stratford, London, E.
		Boam, F. W.
Feb. 7, 1878		Bodmer, Richard, Analytical Laboratory, 16, Southwark-street, London, S.E.
Dec. 6, 1883		Bohm, William Dunsmore, A.R.S.M., F.I.C., 49, Avenue road, Acton, W.
Mar. 18, 1869	Trans.	Bolas, Thomas, 60, Grove-park-terrace, Chiswick
Feb. 18, 1892		Bond, Frederick Fielding, M.D., Rosemary House, Rastrick, Yorks
June 17, 1858		Bond, F. T., M.D., Gloucester
Feb. 1, 1883		Bond, Henry C., M.A., Bromley Park School, Bromley, Kent
May 4, 1893	Trans.	Bone, William Arthur, Owen's College, Manchester
Feb. 16, 1893		Boone, W. T., 6, Mount Pleasant-road, South Tottenham, N.
Mar. 1, 1877		Borland, John, F.L.S., Etruria, Kilmarnock
April 17, 1884		Borland, W. D., Beacon Lodge, Green street, Green, near Dartford, Kent
Mar. 17, 1881		Borus, Henry, Ph.D., 19, Alexandra-road, Wimbledon, S.W.

Date of Election.

May 16, 1895		Borradaile, L. A., Selwyn College, Cambridge
Feb. 2, 1861		Bosanquet, R. H. M., F.R.S.
Feb. 15, 1894		Bose, Prof. Chuni Lal, 24, Mohendro Bose's-lane, Calcutta
June 16, 1881		Bostock, G. H., Broadbottom Hall, near Manchester
Dec. 15, 1881	Trans.	Bothamley, Charles H., F.I.C., Wentworth, Weston-super-Mare
June 16, 1887	Trans.	Bott, William, Ph.D., Raffles Institution, Singapore
Mar. 6, 1873		Bottle, Alexander, 4, Godwyn-road, Dover
June 15, 1871		Bottomley, James, B.A., D.Sc., Homer-terrace, 220, Lower Broughton-road, Manchester
May 15, 1869		Bottomley, James T., M.A., F.R.S., F.R.S.E., 13, University Gardens, Glasgow
Dec. 2, 1886		Bottomley, W. Beecroft, Ph.D., 15, Lillyville-road, Fulham, S.W.
Feb. 15, 1894		Boul, William Good, M.A., Tideswell Grammar School, near Buxton
Dec. 3, 1891		Bovell, John R., Dodd's Botanical and Experimental Station, Barbados
April 20, 1865		Bowdler, A. C., 20, Bank-terrace, Wellington-street, Blackburn
Dec. 6, 1888		Bower, Frank, 164, Marylebone-road, N.W.
May 3, 1894		Bowes, Harry, 53, Moss-lank, Higher Crumpsall, Manchester
Dec. 7, 1893		Bowman, Frederic Edmund, Mayfield, Knutsford, Cheshire
Nov. 6, 1862		Bowman, Frederick H., F.R.A.S., F.L.S., F.G.S., Mayfield, Knutsford, Cheshire
Feb. 20, 1896		Bowman, H. L., B.A., 13, Sheffield-gardens, Kensington, W.
Feb. 20, 1896		Bowley, J. J., 34, Elm-park-road, Chelsea, S.W.
Dec. 16, 1869	Trans.	Bowrey, J. J., Kingston, Jamaica
Dec. 6, 1894	Trans.	Boyd, D. R., Mason College, Birmingham
April 15, 1869		Braby, Frederic, Bushey Lodge, Teddington
Mar. 2, 1876		Bradley, Nathaniel, Sunnyside, Whalley Range, Manchester
May 16, 1895		Bradford, H., c/o E. G. Clayton, 32, Holborn-viaduct, E.C
June 21, 1888		Bradshaw, Charles, 10, The Nook, Barber-road, Sheffield
Mar. 17, 1881		Braga, J. F., F.G.S., F.L.S., F.R.G.S., 1, Albert-villas, High-road, Chiswick
Dec. 6, 1894		Brame, J. S. S., Royal College of Science, South Kensington. S.W.
Nov. 20, 1890		Branson, Charles F., Frankfort House, West-side, Clapham Common, S.W.
Dec. 7, 1882		Branson, F. W., 14, Commercial-street, and Wynneholme, Fur-Headingley, Leeds
June 15, 1882	Trans.	Brauner, B., Ph.D., University of Prague, Bohemia, and Spálená ulice, 1, Prague, Bohemia
Dec. 6, 1883		Briant, Lawrence, 24, Holborn-viaduct, E.C.
Dec. 4, 1890	Trans.	Brierley, John Thomas, 96, Bolton-road, Chorley, Lancashire
May. 4, 1893	Proc.	Briggs, John Frederick, Sugar Refinery, Sakri, near Darbhanga, Behar, India

Date of Election.

April 19, 1883		Briggs, T. Lynton, 357, Madison-street, Brooklyn, New York, U.S.A.
Dec. 18, 1884		Briggs, William, 32, Red Lion-square, Holborn, W.C.
Feb. 6, 1890		Brindley, George F., Aluminium Company, Oldbury, near Birmingham
April 4, 1889		Broadbent, Harry, A.I.C., 125, Belle Vue-road, Leeds
Feb. 6, 1879		Broadbent, John J., Ellesmere House, Patricroft, near Manchester
Feb. 1, 1883		Brock, John, J.P., Gwern-Tyno, Colwyn Bay, N. Wales
Feb. 16, 1893		Brockbank, John Edwin, The Croft, Kirksanton, viâ Carnforth
Dec. 18, 1884		Brodie, Sir Benjamin V. S., Bart., Brockham Warren, Betchworth
Feb. 16, 1893		Brooke, Edward, West-court, Chalk, Gravesend, Kent
Dec. 16, 1886	Trans.	Brothers, H. E., F.I.C., B.Sc. Lond., Park-terrace, Tunstall, Staffs.
Jan. 17, 1884		Brough, Bennett Hooper, A.R.S.M., F.I.C., F.G.S., 28, Victoria-street, S.W.
May 4, 1876	Trans.	Brown, Adrian John, 6, Alexandra-road, Burton-on-Trent
Dec. 5, 1867	Trans.	Brown, Dr. A. Crum, F.R.S., 8, Belgrave-crescent, Edinburgh
Mar. 17, 1870		Brown, David, 93, Abbey-hill, Edinburgh
June 18, 1891		Brown, Edward, 32, Courlandsky-street, St. Petersburg, and care of Wm. Brown, Heaton-street, Cleckheaton
Mar. 20, 1873	Trans.	Brown, Frederic Douglas, Prof., B.Sc., Univ. Col., Auckland, New Zealand
Mar. 20, 1884		Brown, F. W., 43, Elgin-avenue, Maida Hill, N.W.
May 5, 1892		Brown, George Fitz, The Broughton Copper Company, Ditton, Copper Works, Widnes
June 17, 1880		Brown, Henry, Cannon Brewery, Watford, Herts
Jan. 19, 1871	Trans.	† Brown, H. T., F.R.S., 52, Nevers-square, Kensington, W.
Mar. 7, 1867	Trans.	Brown, James Campbell, D.Sc., Chemical Laboratory, Brownlow-street, Liverpool
Mar. 16, 1881		Brown, Joseph, Ashleigh House, Savile Town, Dewsbury
May 4, 1893		Brown, Ralph E., Cordite Works, Arklow, co. Wicklow
May 5, 1892		Brown, Reginald B., Yorkshire College, Leeds
Feb. 19, 1891		Brown, Robert John, The Technical School, Stockport
Dec. 18, 1884		Brown, William George, Ph.D., Department of Agriculture, Washington, D.C.
Dec. 7, 1893		Browne, Frank, Government Civil Hospital, Hong Kong
Feb. 20, 1873		Brownen, George, 16, Althorpe-road, Upper Tooting, S.W.
Dec. 4, 1890		Brownsword, Frank, Thorn Villa, Heaton Moor, Stockport
Dec. 6, 1894	Trans.	Bruce, James, Eskdale, Hawkhead-road, Paisley
May 16, 1895		Bruckmann, G. T., B.Sc., 192, Eighteenth-street, Brooklyn, N.Y.
Dec. 7, 1893	Trans.	Brunton, John Dixon, Wire Mill, Musselburgh, near Edinburgh
June 21, 1877		Buch, C. von, 20, Hanover-street, W.
June 21, 1877	Trans.	Buchanan, J. Y., F.R.S., 10, Moray-place, Edinburgh

† Longstaff Medallist, 1894.

Date of Election.

May 4, 1893		Buchanan, Joshua, Buffels and Red Reef Synd., Port Kantoor, Buffelsdoorn, S.A.R.
June 1, 1876		Buckmaster, C. A., 16, Heathfield-road, Mill-hill Park, Acton, W.
Mar. 1, 1852	Trans.	Buckton, G. B., F.R.S., Weycombe, Haslemere, Surrey
June 20, 1878		Budden, E. Russell, 11, Furnival-street, Holborn, E.C.
Dec. 20, 1842		Bullock, Lloyd, 3, Hanover-street, Hanover-square, W.
Feb. 20, 1896		Burbridge, J. K., Moor's Lea, Winchmore Hill.
Dec. 3, 1891		Burford, Samuel Francis, Eastleigh, Queen's-road, Leicester
Feb. 15, 1894		Burgess, Herbert Edward, 16, Bloomsbury-street, W.C.
Dec. 5, 1889		Burgess, John, 7, Wellington-road, Peckham
June 19, 1884		Burgess, William Thomas, F.I.C., Beech-road, Reigate Hill.
Feb. 21, 1884		Burland, Jeffrey H., 287, University-street, Montreal
Dec. 6, 1894		Burman, G. W., 9, Ebor terrace, Woodhouse Hill, Hunslet, Leeds
Mar. 19, 1849	Trans.	Burnard, Charles F., Plymouth Chemical Works, Plymouth
June 4, 1885		Burnett, Joseph Fearon, 8, River View, Ashton, Preston
May 4, 1893		Burnett, William Robert, Univ. Ext. College, Reading
May 4, 1893		Burnham, John Charles, Gunpowder Factory, Kirkee, Poona, India
May 4, 1882		Burrell, B. Arthur, 5, Mount Preston, Leeds
Mar. 6, 1890		Burton, William, Clifton Junction, near Manchester
Feb. 21, 1884		Bush, Richard A., Holmdale, Baron-grove, Mitcham
Feb. 16, 1882		Bush, Baron William de, Artillery-lane, E.C.
Dec. 6, 1894		Bush, William, Eastgate Villa, Chepstow-road, Newport, Mon.
Dec. 5, 1889		Butcher, W. F., 32A, Lea-terrace, Blackheath, S.E.
Dec. 4, 1890		Butcher, William J., The Grammar School, Ashburne, Derbyshire
Feb. 21, 1895		Butler, D. Butler, 41, Old Queen street, Westminster, S.W.
Dec. 4, 1890		Butler, William Waters, The Cedars, Duchess-road, Edgbaston, Birmingham
May 3, 1894		Buttmer, Robt. Wm., St. Mary's, Godalming
June 3, 1875		Butterfield, J. C., 79, Endlesham-road, Balham, S.W.
Feb. 18, 1892		Butterfield, W. J. Atkinson, Beckton, E.
Dec. 15, 1892		Buttfield, Horace Vincent, 13, Wellington-road, Bush Hill Park, Enfield, N.
June 15, 1893		Cahill, Robert S., 90, Park-lane, Norwich
Feb. 15, 1894	Trans.	Cain, John Cannell, D.Sc., Stubbins Villa, Stubbins, near Manchester
Dec. 7, 1893		Caines, C. M., 158, Elgin-avenue, Maida Vale, W.
Dec. 3, 1891		Calder, William A. S., Cawdor, Grove Park, Camberwell
June 19, 1884		Caley, Edward J., Eaton Old House, Norwich
Dec. 21, 1871		Calvert, J. H., Oakenshaw Print Works, near Accrington
Dec. 6, 1894		Cameron, Alex., Agricultural Laboratory, 4, Lombard-court, E.C.
June 17, 1875		Cameron, J. Macdonald, F.G.S., F.I.C., Royal Mint, Sydney, N.S.W.
May 4, 1893		Cameron, James, 3, Bridge-street, Port Sunlight, nr. Birkenhead

Date of Election.

Dec. 15, 1892		Campbell, Andrew, The Palens, Dunmeedaw, Rangoon, Burmah
Dec. 6, 1883		Campbell, J. Morrow, B.Sc. F.R.G.S., c/o J. Morrow, Oakfield House, Anfield, Liverpool.
June 7, 1888		Campbell, Rev. Joseph, St. Nicola's College, Randwick, N.S.W.
Feb. 20, 1896		Candy, J., B.Sc., 101, Gower-street, W.C.
Mar. 20, 1884		Cannon, Matthew, Lavender Hill, S.W.
Feb. 16, 1888		Carey, Alfred Edward, M.Inst.C.E., F.R.G.S., F.G.S., 39, Trinity-square, Tower Hill, E.C.
May 5, 1892		Carey, Arthur, B.Sc., Browside, Gateacre, near Liverpool
Feb. 21, 1889		Carmody, P., Prof., F.I.C., Government Laboratory Port of Spain, Trinidad
May 6, 1875		Carpenter, H. S., F.I.C., 32, Holborn-viaduct, E.C.; and Beckington House, Weighton-road, Anerley, S.E.
Feb. 21, 1895	Trans.	Carr, Francis H., Meaburne, Warham-road, Croydon
Nov. 17, 1887		Carrington, George Carrington, Missenden Abbey, Great Missenden, Bucks
Dec. 7, 1882		Carruthers, Robert, 90, High-street, Dumfries
Dec. 7, 1893		Carswell, Thomas Retson, 19, Cheetham-place, Cheetham Hill, Manchester
June 16, 1864		Carteighe, Michael, 180, New Bond-street, W.
Dec. 5, 1867		Carulla, F. J. R., 84, Argyle-terrace, Rose Hill, Derby
Feb. 21, 1895		Case, T. B., B.A., 82, James-street, Dublin
Feb. 6, 1879		Cassal, C. E., Vestry Hall, Mount-street, Grosvenor-square, W.
Dec. 6, 1894		Catherall, Ezra, 7, Portman-terrace, Taunton
Mar. 5, 1874		Chaloner, George, 30, Weston-park, Crouch End, N.
Dec. 2, 1880		Chamberlain, A. G., Rugby
May 3, 1894		Chambers, J. F., Grammar School, Dursley, Gloucestershire
Dec. 20, 1883		Chambers, Thos., Dudley House, Coatbridge, N.B.
Feb. 1, 1883		Chambres, Gordon Crewe, Rev., Grammar School, Wigan
Feb. 1, 1872		Chance, Alexander M., Alkali Works, Oldbury, near Birmingham
		Chandler, Charles F., Ph.D., Columbia College, 41, East 49th-street, New York
Feb. 1, 1872		Chandler, William H., Prof., Lehigh University, Bethlehem, Pennsylvania
Feb. 21, 1889		Chaplin, Edward Mitchell, Ph.D., 60, Westgate, Wakefield
Dec. 5, 1895		Chapman, A. J., Burleigh House, Yerbury-road, Upper Holloway, N.
June 17, 1886	Trans.	Chapman, Alfred C., F.I.C., 23, Leadenhall-street, E.C.
Jan. 16, 1868		Chapman, Edward, Hill End, Mottram, Manchester
Dec. 18, 1884		Chapman, Herbert M., The War and Sporting Smokeless Powder Company, Trimley, Suffolk
May 7, 1891		Charles, Rhys Pendrill, Plas Newydd, Neath
Feb. 15, 1894	Trans.	Chattaway, F. D., D.Sc. Lond., Ph.D. Mun., B.A. Oxon., Chemical Laboratory, St. Bartholomew's Hospital, E.C.

Date of Election.

Dec. 5, 1895		Chattaway, W., Apothecaries' Hall, E.C.
May 16, 1895		Cheadle, Walter W., B.A., 19, Portman-street, W.
Dec. 4, 1890		Cheetham, T. A., Allan Glen's School, 68, North Hanover-street, Glasgow
Dec. 5, 1878		Cheshire, H. F., Public Analysts' Laboratory, Hastings
Jan. 19, 1882		Chester, Edward D.,
Dec. 16, 1875		Cheverton, George, F.L.S., South Lawn, Tunbridge Wells
Jan. 16, 1868		Child, Gilbert W., Holywell Lodge, Oxford
Dec. 21, 1871		Childs, Christopher, M.D., Oxon, 10, Manchester-square, W.
Dec. 3, 1891	Trans.	Chorley, John C., Lodge-lane, Bewsey, Warrington
Dec. 17, 1885		Christopher G., Walkden Works, Verney-road, Bermondsey, S.E.
Dec. 7, 1882		Chrystal, William J., 7, West George-street, Glasgow; and Shaw-field Works, Rutherglen, near Glasgow
Mar. 3, 1856	Trans.	Church, Arthur Herbert, F.R.S., Shelsley, Kew, Surrey
April 19, 1888	Trans.	Claisen, Ludwig, Ph.D., Chemisches Laboratorium, Technische Hochschule, Aachen, Prussia
Dec. 15, 1892		Clark, Ernest Victor, 34, St. Aubyns, Hove, Sussex
Dec. 7, 1876	Trans.	Clark, John, Ph.D., 138, Bath-street, Glasgow
Feb. 16, 1852	Trans.	Claudet, Frederic, 6, Coleman-street, E.C.
April 15, 1886		Clayden, Arthur W., M.A., F.G.S., St. John's, Polsloe-road, Exeter
Dec. 7, 1882		Clayton, E. Godwin, F.I.C., 32, Holborn-viaduct, E.C.
May 4, 1893		Clayton, George, School of Pharmacy, 100, Burlington-street, Manchester
Feb. 21, 1889		Clayton, John William, Benfield, Alma-road, Aigburth, Liverpool
Dec. 4, 1873	Trans.	Cleminshaw, Edward, M.A., Alkali Works, Oldbury, near Birmingham
May 20, 1875		Clerk, Dugald, 18, Southampton-buildings, Chancery-lane, W.C.
May 19, 1856		Clift, Samuel, 63, Dudley-road, West Bromwich
Feb. 7, 1878		Cloud, Thomas Charles, A.R.S.M., Walaroo Smelting Works, Walaroo, South Australia
Mar. 18, 1869	Trans.	Clowes, Frank, D.Sc., University College, and 99, Waterloo-crescent, Nottingham
Feb. 3, 1887		Coates, William Henry, M.A., M.B., L.S.Sc., M.R.C.S., L.R.C.P., L.S.A., Bleak House, Patrington, Yorkshire
Mar. 6, 1890		Colbold, Paul Alexander, Hailsbury via Mat-tawa, Ontario, Canada,
May 16, 1895		Coblentz, V., 115-119, W. 63th-street, New York
Dec. 18, 1879		Cochran, Michael, M.A., Wiesbaden, Kollupitiya, Colombo, Ceylon
Dec. 2, 1880		Cockburn, Arthur Cecil, 22, Streatley-road, Brondesbury, N.
Dec. 5, 1895		Cockburn, G. B., B.A., St. George's Hospital, S.W.
June 16, 1892		Cockerill, Thomas, 105, Derby-street, Bolton
Dec. 7, 1893		Cocking, Allan Thomas, Rowley Robert-road, Handsworth Birmingham

Date of Election.

Feb. 16, 1888		Cocking, Lewis Smith, Wharf Mills, Apsley, Huddersfield
Feb. 17, 1881		Coffin, Walter H., 94, Cornwall-gardens, South Kensington, and Junior Athenæum Club, S.W.
Mar. 5, 1885	Trans.	Cohen, Julius B., Yorkshire College, Leeds
Feb. 19, 1891	Trans.	Colefax, Arthur, Ph.D., M.A., 4, Brick-court, Temple, E.C.
April 19, 1883		Coleman, Joseph Bernard,
		Coleman, T. H., Bryn Edwyn, Regent-street, Wrexham
Mar. 1, 1883		Collenette, Adolphus, 11, Commercial-arcade, Guernsey
Nov. 6, 1873		Collens, Edward, Stourbank House, Stourport, Worcestershire
June 16, 1881		Collett, John Marton, Guys Cliff, Wotton, Gloucester
Feb. 5, 1885	Trans.	Collie, J. Norman, Ph.D., 16, Campden-grove, Kensington, W.
Feb. 18, 1892		Collins, Hugh Brown, B.Sc., 121, West George-street, Glasgow
Feb. 6, 1890		Collins, Sydney Hoare, East Lynne, Dehra Dun, N.-W. Prov., India
Feb. 16, 1888		Collins, W. Hepworth, Bradford-buildings, Bolton
Mar. 17, 1887	Trans.	Colman, Harold G., Ph.D., 23, Stirling-road, Edgbaston, Birmingham
May 15, 1890		Colwell, James Kear, F.I.C., 101, Great Russell-street, W.C.
May 5, 1892		Comyns, Frank B. A., 55, South-street, Durham
June 13, 1891		Congdon, Prof. Ernest A., The Drexel Institute of Art, Science, and Industry, Chestnut-street, Philadelphia, Penn, U.S.A.
Feb. 18, 1875		Connor, Charles C., B.A., Notting-hill House, Malone, Belfast
April 19, 1883		Conrad, Edwin C., 12, Briggs-street, Norwich
Feb. 15, 1877		Conroy, Michael, Woodstock, New Brighton, Cheshire
Jan. 18, 1866	Trans.	Conroy, Sir John, Bart., F.R.S., Balliol College, Oxford
Dec. 2, 1875	Trans.	Cook, E. H., D.Sc. (Lond.), the Clifton Laboratory, 27, Berkeley-square, Clifton, Bristol
Nov. 5, 1874		Cook, Edward Riler, East London Soap Works, Bow
May 16, 1895		Cook, Herbert W., Grammar School, Ripon
Dec. 4, 1890		Cooke, Arthur William, Portland Cement Works, Granville, Sydney, N.S.W.
Feb. 2, 1883		Cooke, F. Barker, F.I.C., Messrs. Bostock and Co., South Dock, Garston, near Liverpool
Nov. 15, 1888		Cooley, Walter Bromley, 5, Dudley-street, Wolverhampton
May 18, 1857		Coomber, Thomas, Rosehurst, Clarendon road, Redland, Bristol
Jan. 17, 1889		Cooper, Albert, Grimston Lawn, Haven Green, Ealing, W.
Dec. 15, 1892		Cooper, Arthur James, Minavon Park-avenue, Worcester
Feb. 16, 1888		Cooper, Astley, Oatlands Chemical Works, Meanwood-road, Leeds
May 7, 1891		Cooper, Walter Johnson, South Wales Cement Works, Penarth, near Cardiff
Dec. 6, 1894	Proc.	Coote, A. H., Fernleigh, Sundorne-road, Charlton
April 15, 1880		Copas, Edwin Charles, M.A., The Grammar School, Handsworth, Birmingham
May 15, 1890		Copeman, Sydney Monckton, M.A., M.D. (Cantab), Local Government Board, Whitehall, S.W., and 9, Duke-st., St. James, S.W.

Date of Election.

Feb. 19, 1891	Trans.	Corbett, Charles Henry, the Avenue, Trowbridge, Wilts
Mar. 1, 1866		Corfield, W. H., M.A., M.D. (Oxon), F.G.S., Professor of Hygiene and Public Health, University College, W.C., and 19, Saville-row, W.
Dec. 6, 1888		Cornish, Vaughan, Branksome Cliff, Bournemouth.
April 17, 1890		Corrie, David, Nobel's Explosives Company, West Quarter Factory, Polmont Station, N.B.
June 15, 1883	Trans.	Coste, John Henry, 206, Amburst-road, Hackney, N.E.
June 16, 1892		Couldrey, Henry, H.M.'s Mint, Bombay, India
Dec. 17, 1885		Cousins, William J., 11 and 12, Southampton-buildings, Chancery-lane, W.C.
Dec. 16, 1886	Trans.	Coutts, Francis J. H., Green Mount, Plymouth-grove, Manchester
Dec. 7, 1882		Cowie, Thomas R.
Feb. 6, 1873		Cownley, Alfred J., 13, Fenchurch-avenue, E.C.
April 19, 1888		Cowper, Joseph, 50, King-street, Penrith
Dec. 2, 1886		Cox, Ebenezer John, Orwell Bank, Greenwell-road, Harborne, Birmingham
Dec. 4, 1873		Cox, Samuel Herbert, 13, St. Helen's place, London, E.C.
Dec. 1, 1870	Trans.	Crafts, Prof. J. M., 59, Marlborough-street, Boston, Mass., U.S.A.
Dec. 15, 1892		Craig, Andrew William, 77, Peel street, North Melbourne, Victoria
Feb. 20, 1896		Craig, James, M.A., B.Sc., 6, Montague-street, Great Western-road, Glasgow
June 3, 1875		Crampton, George
Dec. 7, 1893		Craw, John A., Friedländerweg 14, Göttingen
Mar. 16, 1882		Crawley, H. Howard, Saugeen School, Bournemouth
May 20, 1875		Cresswell, Charles Gerard, Ermyngarth, Ashted
Mar. 3, 1887		Cribb, Cecil H., B.Sc., 136, Shaftesbury-avenue, W.
April 4, 1889		Cridland, Francis E. J., Analytical Laboratory, 192, Palmerston-buildings, Old Broad-street, E.C.
June 20, 1878		Criper, William Risdon, Chemical Works, Koonagar, Calcutta
Dec. 5, 1895		Crocker, C., St. Peter's road, Cockett, Swansea
May 20, 1886	Trans.	Crompton, Holland, 723, Fulham road, Fulham, S.W.
Dec. 3, 1857	Trans.	Crookes, William, F.R.S., 7, Kensington Park-gardens, W., and Athenæum Club, Pall Mall, S.W.
Feb. 6, 1879	Trans.	Cross, Charles Frederick, 4, New-court, Lincoln's-inn, W.C.
Dec. 4, 1890	Trans.	Crossley, Arthur W., M.Sc. (Vict.), Ph.D., Chemical Laboratory, St. Thomas's Hospital, S.E.
Feb. 21, 1895		Crossman, Tom, 40, Coldhurst street, Oldham.
Dec. 2, 1880	Trans.	Crow, John Kent, D.Sc., 23, Vanburgh-hill, Blackheath, S.E.
Dec. 1, 1887		Crowther, H. Woodward, The Beeches, West Bromwich
June 20, 1895		Croysdale, John, Whitley Bridge, R.S.O., Yorkshire
June 19, 1884		Crumbie, William D., 146, Washington-street, East Orange, New Jersey, U.S.A.

Date of Election.

Mar. 17, 1887	Trans.	Cundall, J. Tudor, The Academy, Henderson-row, Edinburgh
Dec. 27, 1875		Curphey, W. S., 15, Baile-mansions, Glasgow
Feb. 21, 1889		Curragh, John, Donaghadee, Belfast
Dec. 15, 1881		Custance, John D., Prof. of Agriculture
Dec. 5, 1895		Cuthbertson, G., 69, Shoreham-street, Sheffield
Feb. 15, 1894		Dains, Herbert H., F.I.C., 3 Cantonment, Vizianagram, India
Dec. 7, 1882		Dampier, Henry L., Hill Brow, Strood, Kent
June 16, 1887		Daniell, L. C., Royal Standard Brewery, Tamworth, N.S.W.
April 15, 1850		Danson, Joseph,
Feb. 18, 1892		Darbishire, Francis V., Rossplatz 12, I., Leipzig
Nov. 15, 1852		Darby, Stephen, 140, Leadenhall-street, E.C.
Dec. 3, 1891		Darling, Thomas, Adderstone House, Berwick-on-Tweed
May 4, 1871	Trans.	Darling, William Howarth, 126, Oxford-street, Manchester
Nov. 8, 1886		Davenport, Bennett F., M.A., M.D., 161, Tremont-street, Boston, Mass., U.S.A.
Nov. 18, 1875		Davey, G. W., Bleak House, Barking Creek
Feb. 16, 1893		Davey, George, Fernleigh, Claremont-road, Redruth
May 13, 1876		Davidson, Joseph, Green Bank, Holywell-green, near Halifax
Feb. 1, 1866	Trans.	Davies, Arthur E., Ph.D., Tweedbank, West Savile-road, Edinburgh
May 6, 1858	Trans.	Davies, Edward, The Laboratory, 23, Chapel-street, Liverpool
Feb. 16, 1882	Trans.	Davies, G. W., 8, Spring-hill, Stockport
Feb. 15, 1894		Davies, Sam. H., 83, Overstrand-mansions, Battersea, S.W.
Dec. 17, 1857		Davis, J. Frederick, F.G.S., Archbrook, Budleigh-Salterton, Devon
June 6, 1872	Trans.	Davis, Richard Hayton, 26, Regent-parade, Harrogate
Jan. 20, 1876		Davis, T. Sebastian, 199, South Lambeth-road, S.W.
Dec. 7, 1876		Davis, Walter Charles, The Chestnuts, Durdham Down, Bristol
Feb. 21, 1895		Daw, F. W., Eureka-place, Ebbw Vale, Monmouthshire
Nov. 20, 1890		Day, Charles Edwin, 145, Abbey-road, Barrow-in-Furness
Mar. 17, 1881	Trans.	Day, T. Cuthbert, 36, Hillside-crescent, Edinburgh
Oct. 11, 1894		Deane, Leo. M., South Kilworth Rectory, Rugby
Mar. 3, 1859	Trans.	Debus, Heinrich, Ph.D., F.R.S., 1 Obere Sophien-strasse, Cassel, Provinz Hessen, Germany
May 7, 1885	Trans.	Dechan, Martin, Chemical Laboratory, 5, Oliver-place, Hawick
Dec. 3, 1874		Deck, Arthur, 9, King's-parade, Cambridge
April 1, 1869	Trans.	Deering, W. H., 9, Harvey-villas, Hervey-road, Blackheath, S.E.
Dec. 15, 1881		Demareay, Eugene Anatole, 8bis, Bd. de Courcelles, Paris
Dec. 15, 1892		Denison, Joseph R., 1, Park-view-terrace, Manningham, Bradford
Mar. 6, 1890		Dennant, John, F.G.S., Camberwell, Victoria
Dec. 1, 1870	Proc.	Dewar, James, Prof., F.R.S., Royal Institution, Abemarle-st., W.

Date of Election.

Mar. 4, 1886		Dey, Preo Loll, 4, Beadon-street, Calcutta
June 17, 1880		Dey, Rai Kanny Loll Bahadoor C.I.E., 4, Beadon-street, Calcutta
April 15, 1880		Dibdin, W. J., F.I.C., Mayfield, Grange-road, Sutton, Surrey
April 18, 1872		Dickenson, Arthnr John, F.I.C., 4, Shadeloes-road, New Cross, S.E.
May 4, 1893		Dickinson, Henry Winram, South Kensington Museum, S.W.
Dec. 1, 1887		Dickson, T. Arthur, Estate Office Overstone Park, Northampton
Feb. 2, 1860	Trans.	Divers, Edward, Prof., M.D., F.R.S., Hongo, Tokyo, Japan
Feb. 5, 1885	Trans.	Dixon, Augustus Edward, M.D., Queen's College, Cork
Feb. 20, 1896		Dixon, Frank, 73, King Edward-road, South Hackney, N.E.
June 7, 1894		Dixon, George, B.A., Trinity College, Cambridge and St. Bees, S.O., Cumberland
Feb. 3, 1876	Trans.	Dixon, Harold B., F.R.S., Owen's College, Manchester
May 4, 1893		Dixon, Harry W., 20, Moor-crescent, Hunslet, Leeds
Dec. 5, 1895		Dixon, W., 102, Spring street, Bury
Dec. 18, 1862		Dixon, W. A., Technical Coll., 201, Pitt-street, Sydney, N.S.W.
April 17, 1890		Dixon, William, 4, Park-place East, Sunderland
June 15, 1882	Trans.	Dobbie, James Johnstone, M.A., D.Sc. University College, Bangor, N. Wales
Mar. 3, 1887	Trans.	Dobbin, Leonard, Ph.D., Chemical Laboratory, New University-buildings, Edinburgh
Dec. 2, 1875	Trans.	Dodd, T. H., Chemical Department, Royal Arsenal, Woolwich, S.E.
April 19, 1888		Dodd, William Henry, 8, Kempson-road, Telbrook, Fulham, S.W.
Nov. 18, 1886		Dodd, W. Ralph, Oakdene, Bush-hill Park, Enfield
May 5, 1892		Dodds, George Price, 9, Day-street, Sandyford-road, Newcastle-on-Tyne
Dec. 6, 1894	Proc.	Doherty, W. M., Government Laboratory, Sydney, N.S.W.
June 7, 1894	Trans.	Donald, George, Arnold Print Works, North Adams, Mass., U.S.A.
May 5, 1892		Donaldson, Hudson, The Laurels, St. Catharine's-road, Grantham
May 20, 1886	Trans.	Doran, Robert Elliott, Chemical Dept. Queen's College, Cork
May 20, 1886		Dormer, Richard, Garston.
Dec. 6, 1888		Douglas, William, A.I.C., Diamond, Demerara, British Guiana
Nov. 20, 1884		Down, Frederick J., 28, Victoria-road, Old Charlton, Kent, S.E.
Feb. 3, 1887		Downes, Arthur H., M.D., Local Government Board, Whitehall, S.W.
Feb. 21, 1884		Draper, Henry Carter, Weston, Alma-road, Monkstown, co. Dublin
June 18, 1891		Dreaper, W. Porter, 80, Middle Market road, Great Yarmouth
Feb. 16, 1893		Dreyfus, Charles, Ph.D., The Clayton Aniline Co., Clayton, Manchester

Date of Election.

May 16, 1895		Druce, E., Agricultural College, Holmes Chapel, Cheshire
Dec. 4, 1890		Dudley, William L., Prof. Vanderbilt Univ., Nashville, Tennessee, U.S.A.
Feb. 16, 1893	Trans.	Dufton, Samuel Felix, B.A., D.Sc., 6, Park-road, Red Hill, Surrey
May 5, 1892		Duffield, Walter William, 24, Ursula-street, Battersea, S.W.
Feb. 21, 1884		Duggan, T. R., Sunny-bank, Vanburgh-hill, Westcombe-park, Blackheath, S.E.
Jan. 17, 1889		Duisberg, Dr. Carl, Elberfeld, Germany
Dec. 5, 1889		Dukes, Thomas William, P. T. Peterson and Co., P.O. Box 210, Johannesburg, S.A.R.
June 16, 1881		Duncan, Arthur W., 15, Pern-st., Higher Broughton, Manchester
Dec. 6, 1894	Proc.	Duncan, C. C., Royal Agricultural College, Cirencester
Dec. 17, 1863		Duncan, James, 9, Mincing-lane, E.C.
Feb. 15, 1894		Duncan, Dr. John, St. Petersburg, Russia
June 18, 1891		Duncan, William, The Laboratory, 65, Bath-row, Edgbaston, Birmingham
Dec. 6, 1894		Dunn, Fred., 216, Flinders-lane, Melbourne
June 7, 1888	Proc.	Dunn, John, B.Sc., Morgan Academy, Dundee
Dec. 7, 1882		Dunn, J. T., D.Sc., 85, Gloucester-street, Warwick-square, S.W.
Feb. 16, 1893		Dunnington, Francis P., University of Va, Charlottesville, U.S., N.A.
Dec. 3, 1885		Dunstan, M. J. R., M.A., F.R.S.E., Newcastle Circus, The Park, Nottingham
Dec. 12, 1879	Trans.	Dunstan, Wyndham R., Prof., M.A., F.R.S., Scientific Department, Imperial Institute, S.W.
Jan. 19, 1860	Trans.	Dupré, August, Ph.D., F.R.S., Westminster Hospital Medical School, Caxton-street, Westminster, S.W.
June 1, 1871		Durham, Henry, 32, Fitzroy street, Fitzroy-square, W.
Dec. 6, 1883		Durrant, Reginald G., B.A., The College, Marlborough, Wilts
Dec. 6, 1894		Dutson, L. B., 14, Vicarage-place, Walsall
Dec. 6, 1883		Dutta, Ramchandra, Medical College, Calcutta
Dec. 15, 1892		Duxbury, Thomas, 4, Grosvenor-chas., Deansgate, Manchester
Dec. 16, 1875	Trans.	Dyer, Bernard, D.Sc. (Lond.), 17, Great Tower-street, E.C.
Feb. 6, 1890	Trans.	Dymond, Thomas Southall, 78, Duke-street, Chelmsford
Nov. 19, 1885	Trans.	Dyson, Gibson, Ph.D., Temple House, Cheetham Hill-road, Manchester
Mar. 1, 1883	Trans.	Dyson, Septimus, 2, Exchange-place, Middlesbrough
Feb. 7, 1882		Earl, Alfred George, M.A., Ferox Hall, Tonbridge
Feb. 1, 1876		Earp, Francis S., Ph.D., Hannan's Brown Hill Mine, Kalgoorlie, W.A.
April 4, 1889	Trans.	Easterfield, Thomas Hill, M.A., Ph.D., 122, Tenison-road, Cambridge

Date of Election.

Dec. 3, 1891		Eastick, Charles E, Clyde Wharf Refinery, Victoria Docks, E.
Feb. 1, 1881		Eastick, John J., Millaquin Refinery, Bundaberg, Queensland
Dec. 5, 1878	Trans.	Eccles, Herbert, Faun Villa, Briton Ferry, and Briton Ferry Steel Works, Glamorgan
Mar. 17, 1881		Edgell, R. Arnold, Rev., M.A., The College House, Leamington
June 1, 1876		Edmunds, James, M.D., 23, Dover-street, Piccadilly, W.
Feb. 7, 1848	Trans.	Edwards, John B., Ph.D.
May 4, 1893		Edwards, Thomas, Brewery House, Rhymney, viâ Cardiff
Feb. 21, 1884		Edwards, Vincent, Lawes' Chemical Manure Co., Barking Creek, Essex
May 5, 1892		Edwards, Walter N., 4, Herne Hill-road, Camberwell, S.E.
June 16, 1887		Ehrhardt, Ernest Francis, D.Sc., Ph.D., A.M.C. Anilinfabrik Ludwigshafen-am-Rhein
Nov. 20, 1884		Ehrmann, Leon, The Mauritius Engrais Chimiques Co., Port Louis, Mauritius
Feb. 20, 1896		Eiloart, Arnold, Ph.D., Royal College of Science, South Kensington, S.W.
Dec. 1, 1864	Trans.	Ekin, Charles, 143, New Bond-street, W.
Dec. 20, 1883		Ekins, Arthur E., County Laboratory, St. Albans
Nov. 17, 1887		Elborne, William, B.A. (Cantab.), University College Hospital, W.C.
Dec. 3, 1891		Elford, Percy, St. John's College, Oxford
Feb. 7, 1878		Elliott, Arthur H., Ph.D., c/o Consolidated Gas Co., 4, Irving-place, New York City, U.S.A.
Dec. 7, 1893		Ellis, Charles S., A.I.C., 24, Athol-terrace, Mentor-street, Long-sight, Manchester
April 17, 1890		Ellis, Thomas Flower, Widmore, Bromley, Kent
Feb. 7, 1878		Ellis, W. H., School of Practical Science, Toronto, Ontario, Canada
May 5, 1892		Ellison, Henry, junr., Whitechapel-road, Cleckheaton
Mar. 15, 1888		Ellwood, Thomas Ashcroft, 75, Cavendish-road, Haringay, N.
Feb. 16, 1893		Elmore, Alexander Stanley, The Old Hall, Knaresborough, near Leeds
Mar. 4, 1886	Trans.	Elworthy, Herbert Samuel, 19, Hill-road, Baudra, Bombay
Feb. 5, 1885		Embrey, George, Oriel Lodge, Tuffleigh, near Gloucester
Feb. 3, 1887		Emmons, Hamilton
May 16, 1895		Engineer, Dr. K. S., Muir Line Station, Bombay
June 16, 1892		Entwistle, Herbert, Fairholm, Marsland-road, Sale
Dec. 3, 1885		Epps, James, junr., Norfolk House, Beulah Hill, Upper Norwood, S.E.
Dec. 5, 1889		Erskine, J. Kerr, c/o George Goch, G.M. Co., Box 540, Johannesburg, S.A.R.
June 21, 1883	Trans.	Esilman, Alexander, Fleetwood Lodge, 25, Roe-lane, Southport
May 1, 1862		Esson, William, F.R.S., Merton College, Oxford
Feb. 2, 1865		Estcourt, Charles, Vyrnew House, Talbot-road, Old Trafford, Manchester

FELLOWS OF THE CHEMICAL SOCIETY.

Date of Election.

Feb. 2, 1888		Estecourt, Philip Anderson, Chemical Laboratory, 20, Albert-square, Manchester
June 7, 1894		Eumorfopoulos, Nicholas, B.Sc., 1, Kensington Park-gardens, W.
Mar. 16, 1895		Entroppe, A. T., Vancouver, Washington, U.S.A.
May 7, 1891		Evans, Frederick Arthur, The Cape Copper Co., Ookiep, Namaqualand, Cape of Good Hope
June 15, 1876		Evans, Gwilym, 7, Stepney-street, Llanclly, South Wales
May 4, 1893		Evans, Robert Cecil Turle, 2, Clarence-road, Brondesbury
June 16, 1892		Evans, Sir John, K.C.B., F.R.S., Nash Mills, Hemel Hempstead
Dec. 6, 1888		Everard, Arthur George, 27, Northcote-road, Clapham Junction, S.W.
Feb. 15, 1894		Evershed, Frank, Kenley, Surrey
Feb. 20, 1896	Trans.	Ewan, T., B.Sc., Ph.D., Yorkshire College, Leeds
Mar. 15, 1888		Faber, Harald N., Fiona, Lennard-road, Penge, S.E.
May 18, 1865	Trans.	Fairley, Thomas, F.R.S.E., 17, East-parade, Leeds
Feb. 1, 1888		Fallon, J. H. M., c/o Peruvian Corporation, Limited, Lima, Peru
Nov. 15, 1888		Farlie, John B., 6, Ripon-villas, Ripon-road, Plumstead, S.E.
Feb. 21, 1895		Fairrie, Henry, 1, Haydock-road, Liscard, Cheshire
Dec. 5, 1895		Farr, E. H., Uckfield, Sussex
Dec. 1, 1870		Farries, Thomas, 16, Coleman-street, E.C.
Dec. 2, 1880		Farrington, Thomas, M.A., 4, Waterloo-place, Cork
Dec. 5, 1895		Fauvel, C. J., Laboratory, Cranford, Middlesex
Feb. 15, 1894		Fawcett, Joseph Addey, 54, Broxholme-road, Doncaster
May 16, 1895		Fawns, Sidney, F.G.S., A.I.M.M., P.O., Coolgardie, W.A.
Dec. 1, 1887		Fawsitt, Charles A., 9, Foremount-terrace, Dowanhill, Glasgow
May 17, 1888		Fell, John Campbell, George-street, Louth, Lincs.
Dec. 5, 1878	Trans.	Fenton, H. J. H., M.A., Christ College, Cambridge, and 7, Mortimer-road, Cambridge
June 20, 1872		Ferguson, John, Prof., M.A., University of Glasgow
Feb. 4, 1864		Ferreira, A. A., M.P.S.
Feb. 21, 1889		Ferrier, David, 1, Edin-terrace, Perth
Nov. 16, 1882		Ferrier, James, Columbus, Georgia, U.S.A.
Dec. 4, 1873		Field, Charles L., Upper Marsh, Lambeth, S.E.
Dec. 5, 1895		Fielding, P. J. D., 8, St. Joseph's-place, Cork.
May 15, 1890		Findlay, George H., Burmantoft's Brewery, Leeds
Mar. 7, 1872	Trans.	Fisher, Walter William, M.A., 5, St. Margaret's-road, Oxford
April 3, 1873		Fison, Edward Herbert, Stoke House, Ipswich
April 18, 1872		Fison, Frederick William, M.A., 98, Cromwell-road, S.W.
Feb. 15, 1894		FitzGerald, Rev., Henry Purefoy, B.A., Wellington College, Berks
Dec. 19, 1867		Fletcher, A. E., F.I.C., Delmore, Caterham Valley, Surrey
April 16, 1874		Fletcher, Frederick W., North London Chemical Works, Holloway, N., and Beauchamp Lodge, Enfield

Date of Election.

Dec. 3, 1885		Fletcher, Lazarus, M.A., F.R.S., Natural History Department, British Museum, Cromwell-road, S.W.
April 18, 1872	Trans.	Fletcher, Thomas William, Grappenhall, Warrington
June 7, 1894		Flintoff, Robert J. Huxby, Crumpsall-lane, Crumpsall, Manchester
Feb. 18, 1892		Floris, Robert Brooke, Grandtully, Shrewsbury-road, Stonebridge Park, Willesden, N.W.
Dec. 5, 1895		Foakes, Jervis E., Medical School, Caxton street, Westminster
Dec. 6, 1894		Fogg, C. A., 48, Kent-street, Bolton
June 16, 1859		Fogg, Thomas, 6, Clarendon-gardens, Maida-vale, W.
Dec. 5, 1889		Foggie, John, University College, Dundee
May 7, 1885		Follows, Harold, 39, Meadow-street, Moss-side, Manchester
Feb. 21, 1853		Foord, George, Royal Mint, Melbourne, Australia
Dec. 6, 1894		Forbes, D. G., Cue, Murchison, W. Australia
Nov. 19, 1874		Forbes, James, jun., 70, Gracechurch-street
Dec. 5, 1889		Ford, John S., care of Messrs. W. Younger and Co., Abbey Brewery, Edinburgh
Mar. 4, 1886		Formoy, James Arthur, Cheetham, Grange-road, Sutton
Dec. 7, 1893		Forrester, Alexander M., Laboratory, Port Dundas Chemical Works, 20, Canal-bank, Glasgow
Dec. 15, 1892	Trans.	Forster, Dr. Martin Onslow, Royal College of Science, South Kensington, S.W.
Mar. 3, 1856		Forsyth, W. Cay, St. Andrew, 40, Queen's-road, Leytonstone
Feb. 2, 1888	Trans.	Foster, G. C., F.R.S., 18, Daleham-gardens, Hampstead, N.W.
May 16, 1895		Foster, H. Irving, The Elms, Anlaby-road, Hull
April 6, 1865		Foster, Dr. M., F.R.S., Trinity College, Cambridge
April 4, 1872		Foster, Reginald Le Neve, The Firs, North-road, Droylsden, near Manchester
May 7, 1891	Trans.	Fowler, Gilbert J., Dalton Hall, Victoria Park, Manchester
Mar. 16, 1882		Fowler, William, 1, Grace-terrace, Sunderland
Dec. 5, 1895		Fox, Stanley, 23, South-road, Faversham
June 19, 1884		Foye, Martin Hugh, M.B., C.M.,
June 21, 1877		Franchinont, A. E. N., Ph.D., Leiden, Holland
Dec. 18, 1879		Francis, Edward, Ivey Bank, Park Valley, Nottingham
Nov. 6, 1873		Francis, G. Bult, 38, Southwark-street, S.E.
Nov. 7, 1842	Trans.	Francis, William, Ph.D., F.L.S., Manor-house, Richmond, Surrey, and Red Lion-court, Fleet-street, E.C.
Dec. 20, 1847	Trans.	Frankland, E., D.C.L., F.R.S., The Yews, Reigate-hill, Reigate
June 16, 1881		Frankland, Henry, Streonshalk, The Crescent, Linthorpe, Middlesbro'
Dec. 2, 1880	Trans.	Frankland, Percy Faraday, Ph.D., F.R.S., Mason College, Birmingham
Mar. 21, 1867		Fraser, Dr. Angus, 232, Union-street, Aberdeen
May 5, 1892		Fraser, James C., Mercantile-chas., Victoria-square, Adelaide, S.A.

Date of Election.

May 7, 1885		Freear, Harry M., Hedgefield, Harpenden, Herts
June 16, 1887		Freeman, Frederick W., 7, Park Hall-place, East Finchley
Mar. 7, 1867		Freeman, J. Hersee, Stratford House, Stratford, E.
April 4, 1889		Freestone, Joseph T., 1, Kerfield-terrace, New Ferry, Cheshire
Dec. 15, 1892		French, William, Highfield, 135, Walmersley-road, Bury, Lanes.
April 4, 1889	Trans.	Frew, William, Well Park Brewery, Glasgow
Feb. 2, 1871	Trans.	Friswell, R. J., 115, Darenth-road, Stamford Hill, N.
Dec. 18, 1884		Frost, Joe, Moldgreen, Huddersfield
Nov. 20, 1890		Frost, Robert,
April 15, 1880		Fryer, Alfred Cooper, Ph.D., M.A., 13, Eaton-crescent, Clifton, Bristol
May 16, 1895		Fuerst, A. F., Ph.D., 23, Marlborough road, N.W.
Dec. 3, 1891		Fulcher, Lionel William, B.Sc., South Kensington Museum, S.W., and 56, Buckleigh road, Streatham Common, S.W.
Feb. 20, 1896		Fuller, C. J. P., Mona House, Horwich, Lanes.
Feb. 16, 1893		Fuller, Frederick George
Dec. 2, 1886		Fuller, John, Rookwood, Chapter-road, Willesden Park, N.W.
Mar. 1, 1883		Fulton, H. B., 33, St. Dunstan's-road, West Kensington, W.
May 3, 1894		Gabb, George Hugh, 43, Charlotte-street, Fitzroy-square, W.
Feb. 18, 1892		Gaillon, Alfred T., Tulloch House, Perth, N.B.
April 19, 1866		Gale, James, Ph.D., M.A., F.G.S., Galeston, Eton-avenue, South Hampstead
Mar. 4, 1875		Galton, Douglas, Sir, K.C.B., F.R.S., 12, Chester-street, Grosvenor-place, W., and Himbleton Manor, Droitwich
Mar. 17, 1851		Gamble, David, Colonel, C.B., Windlehurst, St. Helens, Lancashire
April 6, 1876		Gamble, J. C., St. Helens, Lancashire
Dec. 6, 1883	Proc.	Garbutt, Llewellyn, M.A., 10, College-street, Winchester
Mar. 15, 1888		Gardiner, James H., 59, Wroughton-road, Balham, S.W.
Feb. 21, 1895		Gardner, H. Edward, Agricultural College, Aspatria, Cumberland
May 4, 1893	Trans.	Gardner, J. Addyman, Chemical Department, Museum, Oxford
Nov. 15, 1888		Gardner, Walter M., Technical College, and Fairmount, Maudslough, Bradford
May 5, 1892		Gargari, Haridas, M.A., Agra College, Agra, India
Dec. 7, 1893	Trans.	Garnett, Henry, 38, Parolles-road, Upper Holloway, N.W.
Jan. 17, 1889		Garrett, Frederic Chas., B.Sc., Durham College of Science, Newcastle
Jan. 20, 1876		Gaskell, Ernest Holbrook, 5, The Grove, Highgate, N.
April 17, 1884		Gaskell, Joseph, 71, Haworth-buildings, Cross-street, Manchester
Jan. 18, 1847		Gatty, F. A., Holland Bank, Accrington, Lancashire
Nov. 4, 1875		Gee, T. Ernest, F.R.C.P., 67, Westbourne-park-road, W.
Mar. 3, 1887		Geisler, Joseph F., Ph.C., Mercantile Exchange Buildings, Hudson and Harrison-streets, New York

Date of Election,		
May 7, 1885		Gemmell, George Harrison, 4, Lindsay-place, Edinburgh
April 17, 1879		Gent, William Thomas, Misterton, Gainsborough
Feb. 21, 1889		Gerland, Conrad, M.Sc., Ph.D., Municipal Technical Laboratory, Blackburn; and Accrington
Dec. 3, 1891		German, George, Junr., Huntingdon House, Ashby-de-la-Zouch
Feb. 21, 1895		Gerrans, H. Tresawna, M.A., 20, St. John-street, Oxford
Nov. 4, 1875		Gerrard, A. W., Chertsey
Dec. 6, 1883		Geyzel, John Lawrence Van, Surgeon-Major, Chemical Examiner, Madras, East India
June 7, 1894		Ghasvala, B. E.
Feb. 6, 1890		Gibbes, Cuthbert C., M.D., M.C., L.R.C.P. Lond., D.P.H. Cantab., F.G.S., F.L.S., 11, York-mansions, Barkston-gardens, Earls Court, S.W.
May 7, 1891		Gibbins, Bevington H. Ocata, Florida, U.S.A., and 177, Red-land-road, Bristol
May 16, 1889		Gibbs, William Taylor, Masson P.O., Que., Canada, via New York
Mar. 5, 1885		Gibson, Adam, c/o Messrs. Pinkerton, Gibson & Co., Thistle-street-lane, East Edinburgh
June 16, 1892	Trans.	Gibson, John, Ph.D., F.R.S.E., F.I.C., 20, George-square, Edinburgh
June 21, 1888		Gibson, W. Humphrey, 122, King's road, Brighton
May 16, 1895		Gilbard, J. F. H., 8, Glaskin-villas, Lea Bridge-road, N.E.
May 18, 1841	Trans.	Gilbert, Sir Joseph Henry, Ph.D., F.R.S., F.L.S., Harpenden, St. Albans
Feb. 1, 1883		Gill, E. Clarendon, Ivy Dene, Christchurch, Hants
Mar. 17 1881		Gill, E. J. G., Wellikuppam, Madras Presidency, India
April 19, 1888		Gill, John, Gwealhellis, Helston, Cornwall
April 6, 1865		Gillman, A. W., 16, Sussex-square, Brighton
Dec. 3, 1885		Girdwood, Gilbert P., M.D., 54, Beaver Hall Hill, Montreal
Dec. 18, 1848	Trans.	Gladstone, John Hall, Ph.D., F.R.S., 17, Pembroke-square, Hyde Park, W.
Mar. 4, 1886		Glenfield, Francis W. S., 27, Gloucester-gardens, Hyde Park-square, W.
Jan. 18, 1872		Glover, George Thomas, The Phospho-Guano Company, Sea combe, Cheshire
May 16, 1895		Goddard, Wm., 11, Granville-road, Middlesbro'
Feb. 21, 1895		Goldfinch, George, Hendon, N.W.
April 4, 1878		Goldschmidt, S. A., Ph.D., care of Columbia Chemical Works, 4 to 51, Sedgwick-street, Brooklyn, New York
May 16, 1889		Goldsmith, Byron B., 19, East 74th-street, New York City, U.S.A.
Dec. 15, 1892		Goodall, Walter, Alma House, Pudsey, near Leeds
Dec. 4, 1890		Goodwin, Thomas S., 7, Drummond-gardens, Jordan Hill, Glasgow

Date of Election.		
Nov. 20, 1890		Gordon, Colin, Storer's Wharf, Cubitt Town, E.
April 21, 1887	Proc.	Gordon, Hugh, M.A. Oxon., The Cottage, Torkington, Cheshire
Mar. 4, 1875		Gordon, J. G., Queen Anne's Mansions, Westminster, S.W.
Mar. 6, 1890		Gossling, Frank, B.Sc., Condebee, Park Side, Hampton Wick
Feb. 1, 1883		Gothard, Frederic, Bearwood House, Burton-on-Trent
Jan. 17, 1889	Trans.	Gott, B. S., B.A., Corinium, St. Mark's, Cheltenham
Feb. 6, 1879		Gough, Thomas, Rev., B.Sc. (Lond.), King Edward's School, Retford, Notts
June 16, 1887		Gover, Herbert J., 29, Piccadilly, Hanley, Staffordshire
Jan. 17, 1889		Gow, Robert J., The Cedars, Hough Green, near Widnes
May 4, 1893		Gower, Alfred Roland, 18, West View-road, Barrow-in-Furness
Feb. 2, 1871	Trans.	Gowland, William, 13, Russell-road, Kensington, W.
Feb. 3, 1887	Trans.	Goyder, George A., Hawkins-road, Medindie, Adelaide, South Australia
June 19, 1884		Grace, W. F., 54, York-road, Hove, Brighton
Feb. 15, 1894		Grafton, Walter, 11, Grosvenor-road, Upton Park, Essex
April 15, 1880	Trans.	Graham, C. Colborne, care of Messrs. Blundell, Spence, and Co., Beverley-road, Hull
May 1, 1862		Graham, Charles, D.Sc., 23, Euston-buildings, Gower-street Station, N.W.
Dec. 5, 1895	Proc.	Graham, E., B.Sc., Dalton Hall, Manchester
Feb. 21, 1895		Grant, D. St. J., M.A., M.B., Lahore, India
Feb. 6, 1890		Grant, James, 9, Arthur-street, Prestwich, near Manchester
May 16, 1895	Trans.	Grant, P. H., 94, Copleston-road, Denmark-hill, S.E.
June 16, 1887		Gravill, Edward D., F.R.M.S., 42, Wahnsley-street, Hull
Dec. 7, 1882		Gray, George, Canterbury College, School of Agriculture, Lincoln, New Zealand
Dec. 15, 1892		Gray, Thomas, Andersonian-buildings, 204, George-street, Glasgow
Feb. 19, 1891		Greaves, Robert Bond, 77, Netheredge road, Sheffield
May 16, 1895		Greaves, W. A., Grammar School, Newark
Dec. 4, 1890		Green, Alfred H., Oaklands, Lowton St. Mary's, Newton-le-Willows
Feb. 5, 1885	Trans.	Green, Arthur George, 13, King's-drive, Heaton Moor, near Stockport
June 15, 1893		Green, Arthur Henry, 176, Lloyd-street, Greenheys, Manchester
June 16, 1887		Green, John Edward, F.I.C., A.R.S.M., 1, Queen's-road, Urms-ton, Manchester
Dec. 5, 1878		Green, Herbert, Hayle Mill, Maidstone
Dec. 5, 1878		Green, Lawrence, Lower Tovil, Maidstone
April 2, 1874	Trans.	Greenaway, Alfred John, F.I.C., 39, Frognaal, Hampstead, N.W.
Dec. 3, 1885		Greene, William H., M.D., 204, North 36th-street, Philadelphia
June 4, 1885		Greenway, Thomas J., 8th Avenue, East Adelaide, South Australia
May 15, 1873		Greenwood, William Henry, Birmingham Small Arms and Metal Co., Adderley Park Works, 21, Portland-road, Birmingham

Date of Election.		
Dec. 6, 1894	Proc.	Greeves, Alf., 25, Balmuir-gardens, Putney, S.W.
June 18, 1891		Gregory, Alfred John, M.D., B.Sc., Colonial Secretary's Office, Cape Town
May 7, 1885		Gregory, G. M., Ghazipur, N.W.P., India
Mar. 1, 1883		Grenfell, Claud, M.A., c/o Miss Boole, 16, Ladbroke-road, W.
Mar. 5, 1874		Greville, Henry Leicester, Diersheim, Churchfields, Woodford
Feb. 20, 1896		Grice, W. T., 9, Dalhousie-square, Calcutta
Dec. 7, 1893		Grieve, William Hatten, 226, Friern-road, East Dulwich, S.E.
Feb. 2, 1888		Griffith, D. Agnew, Bonnington Sugar Co. Ltd., Leith
June 16, 1859		Griffith, George, M.A., College-road, Harrow
Dec. 15, 1881	Trans.	Griffiths, Arthur Bower, Ph.D., F.R.S.E., 12, Knowle-road, Brixton, S.E.
April 17, 1879		Griffiths, Thomas, The Cedars, Clapham Common, S.W.
Feb. 21, 1895		Grime, Herbert, 11, Church-rd., Chorlton-cum-Hardy, Manchester
Feb. 19, 1874	Trans.	Grimshaw, Harry, Sunnyside, North-road, Clayton, Manchester
April 15, 1880		Grimwood, Robert, London County Council, Chemical and Gas Department, 40, Craven-street, W.C.
May 4, 1893		Grimwood, Robert George, 41, Lady Margaret-road, St. John's College Park, N.W.
Dec. 5, 1889		Gripper, Harold, 2, Heald-place, Rusholme, Manchester
Dec. 15, 1892		Gronow, William Thomas, Port Pirie Smelting Works, Port Pirie, South Australia
Dec. 5, 1895		Grossman, E. H., 12, Alfred-place West, S.W.
April 6, 1871	Trans.	Groves, Charles Edward, F.R.S., Kennington-green, S.E., and Guy's Hospital, S.E.
April 20, 1871		Grundy, Cuthbert Cartwright, F.L.S.
Jan. 17, 1889		Gudeman, Edward, Ph.D.
June 7, 1888		Guiterman, Albert L., Ph.D., 36, Primrose Hill-road, N.W.
May 16, 1895		Gunn, A., 66, Finsbury Park-road, N.
Dec. 6, 1888	Trans.	Guthrie, Frederick Bickell, Chemical Laboratory, The University, New South Wales
Nov. 4, 1875		Guyer, James Brett, Wrentham, Higher Erith-road, Torquay
June 4, 1874		Habirshaw, W. M., Glenwood Works, Yonkers, New York, U.S.A.
Feb. 7, 1878		Hadkinson, John
June 7, 1894		Hadley, Arthur, 226, Monument-road, Edgbaston, Birmingham
Dec. 7, 1893		Hadley, Henry Edwin, The School of Science, Kidderminster
Dec. 16, 1886	Trans.	Haga, T., No. 1, Sadowara-Cho, Tokyo, Japan
June 16, 1881		Hailes, Alfred James de, 15, Red Lion-square, W.C.
Dec. 15, 1892		Haines, Walter S., Prof., c/o Rush Med. College, Chicago, U.S.A.
Jan. 20, 1876	Trans.	Hake, H. Wilson, Ph.D., Westminster Hospital, S.W.

Date of Election.		
Dec. 7, 1893		Hale, Henry Ormsby, Oundle School, Northamptonshire
Dec. 3, 1891		Hall, A. D., S.E., Agricultural College, Wye, Kent
Jan. 17, 1889		Hall, Allan T., Ivy Cottage, Willerby, near Hull
Dec. 3, 1891		Hall, Archibald, 34, Bishopsgate-street, E.C.
April 4, 1889		Hall, Rev. James, B.A., B.Sc., Bancroft's School, Woodford, Essex
Jan. 17, 1889	Trans.	Hall, John A., Victoria Chemical Works, Victoria, B.C.
June 1, 1876		Hall, Samuel, East London Soap Works, Bow
Dec. 18, 1884		Hall, Thomas P., M.A., Ph.D., Tabor, Iowa, U.S.A.
Feb. 16, 1893		Haller, Albin, 14, Rue de Metz, Nancy, France
May 16, 1895		Haller, H. L., 27, Hilda-street, Beverley-road, Hull
May 20, 1886		Halliburton, William Dobinson, M.D. Lond., B.Sc. Lond., F.R.S., 9, Ridgmount-gardens, Gower-street, W.C.
Feb. 3, 1859		Hambly, C. H. Burbidge, Holmeside, Hazelwood, near Derby
April 17, 1890	Trans.	Hambly, Frederick J., University College, Dundee
June 7, 1888	Trans.	Hamilton, James C., Arncliffe, Arnside, viâ Carnforth
Feb. 15, 1894		Hamilton, Robert, Leeds Steel Works, Leeds
May 6, 1875	Trans.	Hamlet, W. M., Government Laboratory, Macquarie-street, Sydney, N.S.W.
Dec. 7, 1882		Hammersley, W. A. Leslie, Bridge House, Leek, Staff.
Jan. 18, 1877		Hampton, William, 38, Lichfield-street, Hanley
Feb. 7, 1857		Hanbury, Cornelius, Flough-court, Lombard-street, E.C., and Dynevor House, Richmond, Surrey
June 15, 1893		Hancock, Ernest Albert, Government Laboratory, St. Kitts, Leeward Islands, W.I.
Dec. 5, 1895	Trans.	Hanes, E. S., 108, Alexandra-road, N.W.
Mar. 7, 1872	Trans.	Hannay, James Ballantine, Whitehall Club, S.W.
Feb. 21, 1889		Hanson, Alfred Miall, The Marjorie, Whalley, near Blackburn
Feb. 21, 1895		Hanson, Weldon, 30, Baker-street, Middlesbrough
Feb. 3, 1859	Trans.	Harcourt, A. G. Vernon, M.A., D.C.L., LL.D., F.R.S., Cowley Grange, Oxford
April 16, 1863		Harcourt, L. F. Vernon, M.A., Fairholme, Weybridge
Mar. 17, 1887	Proc.	Harden, Arthur, Ashville, Upper Chorlton-road, Manchester
May 7, 1885		Hards, William Benjamin, B.A. Lond., Science and Art Department, South Kensington, S.W.
Dec. 15, 1892		Hardy, James G., 1, Keir-terrace, Pollokshields, Glasgow
Jan. 20, 1876		Hargreaves, James, Peel House-lane, Farnworth, near Widnes, Lancashire
June 19, 1884		Hargreaves, John, Widnes, Lancashire
Dec. 16, 1875		Harkness, William, Laboratory, Somerset-house, W.C.
June 1, 1876		Harland, R. H., 37, Lombard-street, E.C.
Feb. 7, 1878		Harland, William Dugdale, 25, Acomb-street, Manchester
Mar. 2, 1857		Harley, George, M.D., F.R.S., 25, Harley-street, W.

Date of Election.

Jan. 15, 1874		Harman, F. E., M.R.A.C., c/o Dr. Piggott, 13, Orchard-gardens, Teignmouth, Devon
Dec. 15, 1881		Harrington, William Bury, Leevue, Montenotte, Cork
Feb. 20, 1895		Harrington, Wm., 11, Edgehill, Bransby, Whitehaven
Feb. 21, 1884		Harris, Frank W., Laboratory, G.W. Ry., Swindon, Wilts
Dec. 7, 1893		Harris, Harold, Barrakar Iron Works, Bengal
Feb. 21, 1895		Harris, Harry, Pulo Brani Smelting Works, Singapore
Dec. 17, 1874		Harris, Henry Penley, 15, Coverdale-road, Shepherd's Bush, W.
Dec. 2, 1886		Harris, Sydney Joseph, Leeds School of Science and Technology, Rossington-street, Leeds
June 7, 1894		Harris, Sydney Walters, 15, Lansdowne-terrace, Walters road, Swansea
Feb. 7, 1878		Harris, Thomas Frederick, B.Sc., Bromley Lodge, Bromley, Kent
Feb. 21, 1895		Harris, Walter, B.A., Ph.D., Campbell College, Belfast
May 17, 1888		Harrison, Albert, 72, Windsor-road, Forest Gate
Dec. 5, 1895		Harrison, C. E., M.A., 53, Lansdowne-road, W.
Feb. 15, 1894	Trans.	Harrison, Edward Frank, 51, Holly-avenue, Newcastle
June 21, 1883		Harrison, Hugh Erat, B.Sc., 2, Park-place, Regent's Park, N.W. and Faraday House, Charing Cross road
May 17, 1888		Harrison, J. Burchmere, Government Laboratory, British Guiana
Feb. 19, 1891		Harrold, Frederick W., 18, Maddox-street, W.
Feb. 17, 1876	Trans.	Harrow, G. H., Ph.D., 127, Station-street, Burton-on-Trent
Mar. 4, 1886		Hart, Bertram Harvey, The Elms, Old Charlton, Kent, S.E.
Jan. 21, 1869	Trans.	Hart, F. W., Esq., Holly House, 96, Stoke Newington-road, N.
Mar. 15, 1888		Hart, James, 131, Embden-street, Manchester
May 7, 1891		Hart, William Beaumont, Gransmoor Avenue, Fairfield, near Manchester
Mar. 16, 1882		Hartley, Arthur, Cannon Brewery, Brighton
Dec. 20, 1866	Trans.	Hartley, Walter Noel, Prof., F.R.S., Royal College of Science, Stephen's-green, Dublin; and 36, Waterloo-road, Dublin
Feb. 6, 1890	Proc.	Hartog, P. J., B.Sc., Owens College, Manchester, and 6, Greville-road, London, N.W.
Dec. 3, 1885		Harvey, Ernest Wm., A.R.S.M., 39, Alderbrook-rd., Balham, S.W.
Feb. 17, 1881		Harvey, Sidney, Canterbury
Feb. 15, 1894		Harvey, W. Pellew, Assay and Mining Office, Vancouver, B.C.
May 6, 1875		Hastings, Henry Mitchell, 54, Edith-road, The Cedars, West Kensington
Feb. 21, 1894		Hatfield, J. Adams, 89, Bridge-street, Weine-bury
Feb. 18, 1892		Hatton, William Percy, care of W. R. Hatton and Sons, Wormwood Scrubs
Dec. 2, 1880		Hawkes, Alfred E., M.D. Bruss., L.R.C.P. Edin., 22, Abercromby-square, Liverpool
Feb. 2, 1888		Hawkins, Lewis Walter, 20 Norton Folgate, E.

Date of Election.

Dec. 6, 1894	Proc.	Haworth, E., B.Sc., Hyndburn-bridge, Clayton-le-Moors, Ac- erington
Mar. 3, 1887		Hay, Alexander, 17, Percival-street, Manchester
Feb. 15, 1894		Hayward, Edward Stanley, c/o Mrs. Sauders, 109, High street, Crediton, Devon
Dec. 1, 1887		Head, C. James, F.I.C., 104, Leadenhall-street, E.C.
Dec. 15, 1881		Head, Harold Ellershaw, 5, Ilchester-mansions, Kensington, W.
Mar. 16, 1876		Head, Jeremiah, 47, Victoria-street, Westminster, S.W.
Feb. 16, 1893		Heath, Arthur John, 1, Grove-villas, Redland, Bristol, and Monkton Combe School, Bath
Dec. 3, 1891		Heath, John William, 33, Upper Gloucester-place, W.
Nov. 2, 1876		Hehner, Otto, 11, Billiter-square, E.C.
Dec. 5, 1889		Helbing, H. B., 63, Queen Victoria-street, E.C.
Dec. 4, 1890	Proc.	Heller, William M., B.Sc., 59, Ickburgh-street, Clapton, N.E.
June 3, 1875		Hellon, Robert, Ph.D., Seascale, viâ Carnforth
Jan. 18, 1872		Helm, Henry James, Simonstone, Hammelton-road, Bromley, Kent
Dec. 6, 1894		Helms, Albert, 8, Bridge-street, Sydney, N.S.W.
Feb. 20, 1896		Helps, J. W., 3, Tavi-tock-road, Croydon
Feb. 5, 1885	Trans.	Henderson, George G., Prof., M.A., D.Sc., F.I.C., the Technical College, 204, George-street, Glasgow
Dec. 5, 1895	Trans.	Henderson, James, care of Prof. Dr. Lintner, Polytechnicum München
Feb. 18, 1892		Hendrick, James, Marischal College, Aberdeen
April 19, 1883		Henning, E. C., Anchor Brewery, Dublin
Feb. 21, 1853		Hepburn, J. G., LL.B., Dartford, Kent
June 18, 1885		Hepworth, T. Cradock, 10, Lysias-road, Balham-hill, S.W.
Dec. 5, 1895		Heriot, T. H., P., 23, Wolsley-road, Crouch End, N.
Feb. 16, 1871		Herman, Douglas, Eccleston-park, Prescott
June 15, 1876	Trans.	Heron, John, 110, Fenchurch-street, E.C.
Dec. 7, 1893		Hesketh, William, 16, New Market-street, Blackburn
May 5, 1892	Trans.	Hewitt, John Theodore, People's Palace Technical Schools, E.
Feb. 18, 1892		Hewlett, John C., 40, Charlotte-street, Great Eastern-street, London, E.C.
June 21, 1883	Trans.	Heycock, Charles T., M.A., F.R.S., 24, Fitzwilliam-st., Cambridge
April 1, 1875		Heywood, Charles A.
Dec. 1, 1864		Heywood, Henry, Witla Court, near Cardiff
Dec. 1, 1887		Heywood, J. Garnett, 127, Sutherland-avenue, Maida Vale, W.
Feb. 6, 1890		Heywood, Joseph H., Sparth Cottage, Manchester-road, Roch- dale
April 3, 1848		Heywood, J. S. C., 19, Inverness-terrace, Kensington-gardens, W.
June 1, 1876	Trans.	Hibbert, Walter, 14, Goldhurst-terrace East, South Hampstead, N.W.
June 7, 1894		Hichens, J. H., M.A., F.G.S., The School House, Wolverhampton
Mar. 17, 1881		Hiddingh, Michael, Newlands, near Capetown

Date of Election.

May 7, 1891		Hiepe, William L., Ph.D., The Laboratory, Kilvert's Buildings, Withy Grove, Manchester
Dec. 6, 1894		Higgs, M. S., Clarence House, Russell-street, Gloucester
March 16, 1882		Hill, Alexander
Dec. 16, 1858		Hill, Alfred, M.D., F.I.C., F.R.S.E., Medical Officer of Health, The Council House, Birmingham
Feb. 21, 1895		Hill, E. H., Box 330, P.O., Dunedin, N.Z.
Feb. 15, 1894		Hills, Edmond Herbert, Capt. R.E., Darland House, Chatham
Mar. 5, 1892		Hills, Harold F., Pine Island P.O., Kent, Auckland, N.Z.
May 15, 1873		Hills, Walter, 225, Oxford-street, W.
May 5, 1892		Hinnell, Henry Leonard, 41, Corporation-street, Manchester.
May 3, 1894		Hirsch, C. T. W., M.D., Government Medical Officer, Fiji
Jan. 20, 1870		Hislop, G. R., Gasworks, Blackstoun-road, Paisley
Nov. 18, 1886		Hislop, Lawrence, 33, Slatey-road, Birkenhead
June 21, 1883		Hobbs, Bedo, The Brewery, High-street, Maidenhead
Dec. 18, 1884		Hodges, Herbert J., Stoneleigh, Worple road, Wimbledon
April 15, 1844	Trans.	Hodges, John F., Prof., M.D., F.I.C., J.P., Queen's College, Belfast, and Sandringham, Malone-road, Belfast
Nov. 16, 1882	Trans.	Hodgkin, John, F.L.S., F.I.C., 12, Dynevor-road, Richmond-on-Thames
Dec. 18, 1879	Trans.	Hodgkinson, W. R. Eaton, Prof., Ph.D., F.R.S.E., 8, Park, villas, Blackheath, S.E.
April 15, 1836		Hodgson, Christopher, High House, Eppleby, Darlington
April 17, 1873		Hodgson, H. Tylston, Harpenden, Herts
Dec. 6, 1894		Hogg, A. F., M.A., 73, Stanhope-road, Darlington
May 7, 1885		Hogg, Edward Grindle, 1, Southwick-street, Hyde Park-square, W.
Mar. 1, 1883		Hogg, W. Douglas, M.D., 62, Champs Elysées, Paris
June 11, 1876		Holcroft, Harold, M.A., Parkdale, Wolverhampton
Dec. 3, 1885		Holgate, Thomas, 12, Hyde Park-road, Halifax
Mar. 16, 1876		Holland, Philip, 22, Taviton-street, Gordon-square
Dec. 3, 1891		Holliday, John, The Gas Works, Scarborough
Dec. 2, 1880		Holliday, Robert, Huddersfield
June 18, 1891		Holloman, Frederick R., 396, Barking-road, Plaistow, E.
Mar. 4, 1886		Holloway, George Thomas, 57 and 58, Chancery-lane, W.C.
Dec. 5, 1895		Holme, A. E., M.A., 3, Ash terrace, Saville Town, Dewsbury
Dec. 2, 1886		Holmes, John Winder, 23, Crooms hill, Greenwich, S.E.
Dec. 7, 1893		Holthouse, H. B., 42, St. Ann's-valley, Nottingham
May 4, 1865		Holzmann, M., Ph.D., Marlborough-house, S.W.
Feb. 7, 1878		Hooker, A. H., Board of Health, Cairo, Egypt
Dec. 15, 1892	Trans.	Hooker, Samuel C., The Franklin Sugar Refinery Co., 701, Front-street, Philadelphia
Mar. 1, 1883		Hooper, David, Ootacamund, Madras Presidency, India
May 17, 1888		Hooper, E. Grant, 16, Royal-avenue, Chelsea, S.W.
Feb. 19, 1891		Hooper, Ernest F., Wear Fuel Works, Hendon Dock, Sunderland

Date of Election.

June 7, 1894		Hope, Arthur Peach, Pytchley Manor, near Kettering
Feb. 15, 1894		Horby, R., B.A., The High School, Newcastle, Staffordshire
Dec. 15, 1892		Horsfall, John, Plantation House, Cloughfold, Manchester
Dec. 15, 1892		Horwill, Edgar E. C., Firs Villa, Fitzwilliam-road, Clapham, S.W.
Mar. 4, 1886		Hoskins, Arthur Percy, 25, Cromwell-road, Belfast
Dec. 7, 1882		Hotblack, Herbert A., Cannon Brewery, Brighton
Feb. 16, 1871		Houlder, W. W., 10, Ossulton-villas, Southall-green, Southall
Mar. 17, 1887	Proc.	Houlding, William, B.Sc., 26, Huskisson-street, Liverpool
Feb. 20, 1896		Howard, Albert, 17, Elthiron-road, Fulham, S.W.
Dec. 7, 1882		Howard, Alfred G., Holmbury, Woodford-green, Essex
Feb. 18, 1869		Howard, Alfred Kingsby,
Nov. 3, 1870	Trans.	Howard, David, Devon House, Buckhurst Hill, Essex
April 21, 1887		Howard, D. Lloyd, jun., Alton Lodge, Woodford-green, Essex
Dec. 18, 1879		Howard, John, 22, Ashby-road, Canonbury
Mar. 4, 1875		Howard, Thomas, 50, Ellington-street, Liverpool-road, N.
June 20, 1889		Howard, George William, Calverley, Tanbridge Wells
Dec. 7, 1882		Howe, J. Lewis, M.D., Ph.D., Prof. of Chem, Washington, and Lee University, Lexington, Va., U.S.A.
Feb. 19, 1880		Howell, Reginald, 95A, Southwark-street, S.E.
Jan. 20, 1876		Howie, W. L., Cornbrook House, Clarendon-road, Eccles, Lancashire
Jun. 15, 1893		Howitt, James J., Messrs. Bowman, Thomson and Co., Northwich
April 4, 1889		Hoyle, Richard Ashworth, 11, Market-square, Lytham, Lanes.
April 4, 1889		Hoyles, Henry Richardson, c/o Messrs. Treacher and Co, Byculla, Bombay, and Fern-place, 142, Upperthorpe, Sheffield
Mar. 2, 1871		Hudleston, W. H., M.A., F.G.S., 8, Stanhope Gardens, South Kensington, S.W.
Feb. 21, 1895		Hudson, Percy, 43, Alexandria road, Burton-on-Trent
Feb. 21, 1878		Hudson, William, B.Sc. (Lond.), The Lilies, Twickenham
Feb. 15, 1894	Trans.	Hughes, Frank, 78, Duke-street, Chelmsford
June 17, 1880		Hughes, George Henry, Analytical Laboratory, Barbadoes, West Indies; and 79, Mark-lane, E.C.
Dec. 17, 1868		Hughes, John, Analytical Laboratory, 79, Mark-lane, E.C.
May 17, 1888		Hughes, John, 16, Finsbury-circus, E.C.
Dec. 5, 1889	Trans.	Hughes, Robert Edward, B.A. (Oxon.), B.Sc. (Lond.), Science and Art Department, South Kensington, S.W., and 6, Fairfax-road, Bedford Park, W.
June 4, 1885		Hughes, T. Vaughan, Greenfield Mills, Holywell, North Wales
Nov. 16, 1882		Hughes, Thomas, Borough Analyst, West Wharf, Cardiff; Laboratory, 31, London-square, Cardiff
Nov. 20, 1884		Hulme, James, Newton Chemical Works. Hyde, Manchester
April 19, 1883		Humphrys, Norton H., 4, The Paragon, Wilton-road, Salisbury
Dec. 18, 1879	Trans.	Hummel, J. J., 7, Moorfield-villas, Woodsley-road, Leeds

Date of Election.

Dec. 7, 1893		Hunt, Bertram, P.O., Box 1606, Denver, Colorado, U.S.A.
Mar. 18, 1869		Hunt, Charles, Birmingham Gas Light Works, Windsor-street, Birmingham
Feb. 1, 1883		Hunter, John, 29, Chambers-street, Edinburgh
Dec. 3, 1885		Hunter, Matthew, M.A. Oxon, Rangoon College, Lower Burma
April 4, 1878		Huntington, A. K., Prof., Metallurgical Laboratory, King's College, W.C.
Feb. 16, 1893		Huntly, George Nevill, Balliol House, Whitechapel, E., and 56, Sheen-road, Richmond
Dec. 3, 1885		Hurst, George H., 22, Blackfriars-street, Salford
Mar. 21, 1861		Huskisson, H. O., 5, Gordon-square, London, W.C.
Feb. 15, 1894		Hutchinson, Alfred, B.A., B.Sc., Bryn-y-Mer, Saltburn
Feb. 6, 1890	Trans.	Hutchinson, Arthur M.A., Ph.D., Pembroke College, Cambridge
Jan. 17, 1884		Hutchinson, C. Clark, 193, Romford-road, Stratford, E.
Nov. 19, 1885		Hyatt, H., 1, Milton-road, Herne Hill, S.E.
April 19, 1883		Idris, Thomas Howell Williams, Pratt-street, Camden Town, N.W.
Feb. 7, 1867		Ince, Joseph, 11, St. Stephen's-avenue, Shepherd's-bush, W.
Dec. 15, 1892	Trans.	Ince, Walter H., Ph.D., Port of Spain, Trinidad
April 4, 1839	Trans.	Ingle, Herbert, Poole, near Leeds
Dec. 7, 1871		Irvine, Robert, Royston, Granton, near Edinburgh
Dec. 6, 1883		Irwin, Wilfred, 3, Wilton Polygon, Cheetham Hill, Manchester
Dec. 15, 1892		Isaac, John F. V., Royal York Hotel, Brighton
Feb. 16, 1882		Isherwood, Thomas, B.A., LL.B., University School, Southport
Nov. 19, 1885		Ivatt, Albert, B.A., 38, Glisson-road, Cambridge
May 3, 1894		Jackman, Edwin James, 60, Belgrave-road, Ilford
Feb. 15, 1894	Proc.	Jackson, David Hamilton, M.A., B.Sc., 18, Heathcote-street, Mecklenburgh-square, W.C.
Dec. 7, 1882		Jackson, Edward, 27, Beaufort-road, Edgbaston, Birmingham
Dec. 5, 1889		Jackson, Eric H., B.Sc., Harsfield, Morley-road, Southport
Dec. 18, 1884	Trans.	Jackson, Herbert, 3, Amyand Park Gardens, East Twickenham, and King's College, Strand
Dec. 15, 1892		Jackson, John, Llangorse Villa, Serpentine-road, Gold Tops, Newport, Mon.
Dec. 6, 1883		Jackson, Robert, 18, Harrington-street, Dublin
Dec. 15, 1881		Jackson, R. Valentine, c/o The Scotch and Irish Oxygen Company, Polmadie, Glasgow
Dec. 15, 1892		Jackson, Samuel, c/o Binney and Co., Madras
June 16, 1887		Jadhava, K. B., Ameeli, Kathiwar, India
May 16, 1878	Trans.	Jago, William, F.I.C., 32, Clarendon-villas, Brighton
Dec. 5, 1895		James, Alf., 108A, Hope-street, Glasgow

Date of Election.

Feb. 18, 1888		James, Christopher, care of Elliott's Metal Company, Penabrey Copper Works, R.S.O., Bury Port, South Wales
Feb. 17, 1881	Trans.	James, J. William, Ph.D., 29, Redcliffe-street, Bristol
Feb. 7, 1878		Jamieson, Alexander, 5, St. Mark's-crescent, Regent's Park N.W.
Feb. 6, 1879	Trans.	† Japp, F. R., M.A., LL.D., Ph.D., F.R.S., University, Aberdeen
Feb. 15, 1894		Jardine, Walter, 86, Victoria-place, Perth
Nov. 16, 1882		J'armay, Gustav, Hartford Lodge, Hartford, Cheshire
Feb. 19, 1891		Jenkins, Henry Charles, Royal Coll. of Science, S. Kensington, S.W.
May 5, 1892		Jenkins, John H. B., Chemical Laboratory, G.E. Ry. Works, Stratford, E.
Feb. 15, 1894		Jenks, R. Leonard, Esq., 33, Cantley-avenue, Clapham Common, S.W.
Feb. 15, 1894		Jennison, Francis Herbert, Hollywell House, Theaker-lane, Armley, near Leeds
April 17, 1879		Jewson, Francis A. B., Homefield, Station-road, Clapham
Feb. 4, 1875		Johnson, David, F.G.S., F.R.M.S., 1, Victoria-road, Clapham Common, S.W.
Dec. 5, 1895		Johnson, F. E., 16, Stanley-terrace, Anlaby-road, Hull
Feb. 21, 1878	Trans.	Johnson, George Stillingfleet, 11, Savile-row, W.
Feb. 1, 1883		Johnson, James Edward, 40, Edmiston-road, Stratford, E.
May 16, 1872		Johnson, John Grove, 41, Cross-street, Finsbury, E.C.
May 20, 1886		Johnson, J. T., Oakham School, Rutland
May 10, 1866		Johnson, Samuel H., Warren Hill House, Loughton, Essex
Feb. 20, 1896		Johnstone, James, Braehcad, Parkhill, Rutherglen
Dec. 18, 1884		Johnstone, James D., 9, Orange lane, Montrose
April 17, 1879		Johnstone, William, Ph.D., Effingham House, Arundel-street, Strand, W.C.
Dec. 15, 1892		Johnston, William George, c/o Messrs. Warwick's, The Brewery, Newark-on-Trent
May 20, 1886		Jones, A. Wentworth, M.A. Oxon, Godington Rectory, Bicester
May 16, 1895		Jones, E. L., 4, Bank-buildings, Llandilo
April 6, 1871	Trans.	Jones, E. W. T., The Oaklands, Wolverhampton; and 10, Victoria-street, Wolverhampton
Dec. 4, 1873	Trans.	Jones, Francis, F.R.S.E., Beaufort House, Alexandra Park, Manchester
Dec. 6, 1894		Jones, Geo. Cecil, Basingstoke Ironworks, Hants
May 4, 1876	Trans.	Jones, H. Chapman, Royal Coll. of Science, S. Kensington, S.W.
May 4, 1893		Jones, Hedley Gordon, 72, Queensland-street, Edgehill, Liverpool
May 16, 1878		Jones, Henry Williams, 17, White-street, Coventry
May 15, 1890		Jones, John Archyll, B.Sc., 9, Granville-road, Middlesborough

† Longstaff Medallist, 1891.

Date of Election.

Feb. 19, 1891		Jones, M. William, 50, Mayfield-road, Whalley Range, Manchester
Feb. 18, 1892	Trans.	Jones, Lionel Manfred, St. Dunstan's College, Catford, S.E.
May 7, 1891		Joseland, Walter Herbert, Talke, near Stoke-on-Trent, Staffs.
Feb. 21, 1895		Joseph, Edgar, 42, Brondesbury-road, Kilburn, N.W.
May 4, 1893	Trans.	Jowett, Hooper A. D., B.Sc., 17, Bloomsbury-square, W.C.
Feb. 21, 1891		Jowett, William Hall, 2, Mayfield-road, Aigburth, near Liverpool
May 4, 1893		Káká Sorabji, Manekji, Devon Villa, Karachi, Sind, India
Dec. 16, 1886	Trans.	Kawakita, Michitada, Kantstr, 24, Charlottenberg, Berlin
Feb. 17, 1881	Trans.	Kay, William E., Gowanbank, Busby, near Glasgow
Dec. 5, 1889		Kaye, James R., M.D., Medical Officer of Health, Town Hall, Huddersfield
Dec. 20, 1883		Keeling, Frank, 190, Lake-avenue, Rochester, N.Y., U.S.A.
Dec. 7, 1882		Keen, Austin, 13, Lyndewood-road, Cambridge
May 3, 1894		Kellas, Alex. Mitchell, c/o Frau Müller, Friedrichstr, 10, Heidelberg
Mar. 19, 1874		Kellner, William, Ph.D., Chemical Department, Royal Arsenal, Woolwich, S.E.
April 4, 1867		Kemp, David Skinner, 52, Coverdale-road, Shepherd's Bush, W.
May 4, 1882		Kemp, William Joel, Mountfield, Robertsbridge, Sussex
Dec. 18, 1884		Kendall, George Frederic, B.A., The Hollies, Stratford-upon-Avon
Dec. 17, 1874		Kendall, James Alfred, Lonesome Chemical Works, Streatham Common, S.W.
Dec. 5, 1889		Kenwood, Henry R., M.B., C.M. (Edin.), L.R.C.P. (Lond.), 9, Alexandra-villas, Finsbury Park, N.
Feb. 21, 1895		Kenyon, Rich. E., B.Sc., 14, Hill-lane, Southampton
Dec. 20, 1883		Kerry, William H. R., Wheatlands, Windermere
April 15, 1875		Keyworth, George Alexander, St. Hilary, Hastings
Dec. 5, 1895		Kibble, W. O., G.P.O., Auckland, N.Z.
Dec. 7, 1882		Kilner, Frederick James, Royal Infirmary, Bristol
Jan. 17, 1884		Kilpatrick, W. Stirling, 4, Annfield-place, Glasgow
Feb. 15, 1872	Trans.	Kinch, Edward, Royal Agricultural College, Cirencester
Feb. 17, 1881	Trans.	King, Alfred John, Ingersley Vale, Bollington, near Macclesfield
Dec. 7, 1876		King, J. F., Laboratory of City Analyst, Edinburgh
Feb. 21, 1895		Kingdon, G. Holman, B.A., Taddyforde House, Exeter
Dec. 5, 1872	Trans.	Kingzett, Charles T., Elmstead Knoll, Chislehurst, Kent
Dec. 5, 1895		Kinnicut, Prof. L. P., Worcester, Mass., U.S.A.
Mar. 1, 1877		Kinninmont, Alex., Whitehall, Bothwell, N.B.
May 7, 1891	Trans.	Kipping, F. Stanley, Ph.D., D.Sc. (Lond.), 7, Milborne-grove, South Kensington
Dec. 2, 1886		Kirby, Herbert E., 307, High Holborn, W.C.
May 15, 1890		Kirk, Oliver, 19, Carlton-road, Workington
Feb. 21, 1895		Kirkaldy, Patrick H., 19, Clifton-road, Crouch End, N.

Date of Election.

Feb. 2, 1888	Trans.	Kirkland, J. Booth
June 19, 1873		Kitchin, Archibald, F.I.C., Seragill House, Whitehaven
May 16, 1889		Kitchin, John, The Middlesex Hospital, W.C.
Dec. 6, 1894		Knaggs, Alfred Battye, 2, Bradley-lane, Huddersfield
June 20, 1889		Knight, Frederick Charles, Boston and Colorado Smelting Company, Argo, Colorado, U.S.A.
Dec. 6, 1888		Knight, James, M.A., B.Sc., John-st. School, Bridgeton, Glasgow
May 3, 1894		Knight, Wm. Albt., Sexey's Trade School, Bruton, Somerset
May 16, 1878		Knights, James West, County Laboratory, Cambridge
Dec. 18, 1879		Knowles, Joshua, Stormer-hill, Tottington, Bury
Dec. 15, 1892		Knowles, Thomas Torrens, 27, Peel-street, Princes Park, Liverpool
June 16, 1864		Knox, G. W., B.Sc., 16, Finsbury-circus, London, E.C.
Feb. 6, 1873		Koch, Walter Edward, M.A., F.G.S., Sharpsburg, Allegheny Cy., Pa., and 65, Sandusky-street, Allegheny, Pittsburgh, Pa.
Nov. 17, 1887	Trans.	Koga, Yoshimasa, The Imperial Mint, Osaka, Japan
June 17, 1886	Trans.	Kohn, Charles A., Ph.D., B.Sc., 20 Mulgrave-street, Liverpool
June 8, 1885		Koningh, Leonard de, 325, Kennington-road, S.E.
Dec. 15, 1892		Krause, Dr. G., Cothen, Germany
Feb. 17, 1859	Trans.	Kynaston, Josiah W., Chemical Laboratory, 3, Oak-terrace, Beech-street, Liverpool
Dec. 6, 1894		Ladeil, R. S., 4, The Quadrant, Lime-street, Liverpool
Feb. 3, 1859		Lackersteen, Mark Henry, M.D., M.R.C.P. Lond., M.R.C.S. Eng., F.L.S., The Reliance Buildings, 100, State-street, Chicago, U.S.A.
Feb. 16, 1888		Lafosse, Charles R., Abbotsford, Wildercombe Park, Ilfracombe
May 4, 1893		Lamb, Edmund George, M.A., Old Lodge, Salisbury
Dec. 15, 1892	Trans.	Lamb, Thornton Charles, The Polygon, Ardwick, Manchester
Feb. 16, 1893		Lambert, Wesley, Hotel de Byzance, Rue de Pera, Constantinople, Turkey
Jan. 18, 1877		Lancaster, William James, F.R.A.S., F.R.C.S., F.R.M.S., The Hollies, Handsworth Wood, Birmingham
Mar. 4, 1886		Lang, William, Cross Bank, Partrick
June 18, 1885		Langer, Charles, Ph.D., c/o F. J. Bloomer, Esq., 15, Broderick-road, Upper Tooting, S.W.
May 7, 1891		Langham, Rev. E. Norman, M.A. (Cantab), F.L.S., Head Master, Rastrick Grammar School, Brighouse
June 21, 1877	Trans.	Lapraik, William, Ph.D., F.I.C., 18, Dagmar-road, Camberwell, S.E.
Feb. 16, 1894	Trans.	Lapworth, Arthur, D.Sc., Central Technical Institute, South Kensington
June 21, 1883		Lascelles, B. P., B.A., Harrow
April 15, 1880		Last, Frank B., Laboratory, 78, Mansell-terrace, Swansea

Date of Election.		
May 7, 1891	Trans.	Lauder, Alexander, 12, Lyle-street, Greenock
Mar. 4, 1886	Trans.	Laurie, Arthur P., Woodside, Baldwin Hill, Loughton
Nov. 16, 1876		Law, Channell, Ilsham Dene, Torquay
Feb. 6, 1890	Trans.	Law, Robert, F.R.M.S., F.I.C., The Royal Mint, Melbourne
June 17, 1880	Trans.	Lawes, Sir John Bennet, F.R.S., Rothamsted, near St. Albans
June 17, 1880	Trans.	Lawrance, Henry Awbrey, Avondale House, Bree-street, Cape Town
Jan. 19, 1882		Laws, J. Parry, F.I.C., Westfield, Bath-road, Worcester
Feb. 2, 1888	Trans.	Lawson, Thomas Atkinson, Ph.D., B.Sc., 114, Alexandra-road, N.W.
April 17, 1890	Trans.	Laycock, William Frederick, Ph.D., 2, Park-street, Dewsbury
April 17, 1890		Lea, A. Sheridan, D.Sc., F.R.S., Caius College Cambridge
Dec. 16, 1886		Leach, Walter, 21, St. Andrew's-place, Bradford
Dec. 6, 1894	Trans.	Lean, Bevan, D.Sc., Dalton Hall Victoria Park, Manchester
April 4, 1889		Leaper, Clement Joseph, 19, Belvidere-road, Taunton, Somerset
Feb. 2, 1888		Lease, Frank E., Melapi Estate, Sandakan, British North Borneo
Dec. 3, 1891	Trans.	Leather, J. Walter, Ph.D., Dehra Dun, N.W.P., India
Dec. 5, 1889		Ledingham, L. Napier, Longley Farm, Longley, near Sheffield
Feb. 15, 1894		Lee, Clifford W., East Rand Prop. Mines, Boksburg, Transvaal
Dec. 6, 1883		Lee, Herbert C., The New Westminster Brewery Company, Earl-street, Horseferry-road, S.W.
Feb. 1, 1882		Lee, Robert Brewer, B.Sc., B.A., 6, Warwick-street, Kensington, W.
June 18, 1891		Leeds, Frank H., 26, East Bank, Stamford-hill, N.
Feb. 6, 1873		Lees, Charles, Grange College, Leominster
Dec. 1, 1887		Lees, Samuel, jun., Lyndhurst, Smallshaw, Ashton-under-Lyne
Dec. 3, 1891		Leffler, Rudolf, 75, Havelock-road, Sheffield
May 16, 1889		Legg, John Edmund, M.A., F.I.C., The Grammar School, Wood-bridge, Suffolk
May 7, 1891	Proc.	Leicester, James, 2, Randall-road, Clifton, Bristol
Jan. 17, 1889		Leigh, Cecil, Birmingham Small Arms and Metal Company, Adderley Park Rolling Mills, Birmingham
Dec. 3, 1891		Lennox, Robert N.
Jan. 17, 1889		Lenox, Lionel R., Ph.B.
June 17, 1886		Leon, John Temple, 38, Portland-place, W.
Feb. 15, 1894		Leonard, Norman, B.Sc., 2A, Lorne-road, Brixton, S.W.
Jan. 19, 1882		Lescher, Frank Harwood, 60, Bartholomew-close, E.C., and 31, Devonshire-place, W.
April 17, 1890		Lescher, Herman, 32, Eaton-place, S.W.
Feb. 21, 1895	Trans.	Le Sueur, Henry Rondel, B.Sc., St. Thomas's Hospital, S.W.
Feb. 6, 1879	Trans.	Letts, Edmund Albert, Ph.D., Queen's College, Belfast
Mar. 15, 1888	Trans.	Lewes, Vivian B., 19, Park-row, Greenwich, S.E.
Mar. 20, 1884		Lewis, A. E., 86, Tritonville-road, Sandymount, Dublin

Date of Election.	
Dec. 6, 1894	Trans. Lewis, W. H., Exeter School, Exeter
Nov. 18, 1869	Trans. Lewis, W. J., New Museums, Cambridge
Feb. 16, 1888	Trans. Lewkowitsch, Julius, Ph.D., Lancaster-avenue, Fennel-street, Manchester
Feb. 21, 1878	Lichtenstein, T., Chemical Works, Silvertown, E.
May 5, 1892	Lindley, Hubert Edward, Rose Villa, Pinner-road, Harrow
April 15, 1886	Trans. Ling, Arthur R., 45, Lambton-road, Cottenham Park, Wimbledon
Nov. 21, 1853	Trans. Liveing, G. D., M.A., F.R.S., Cambridge
Nov. 7, 1872	Trans. Liversidge, Archibald, F.R.S., Prof., University, Sydney, New South Wales
June 21, 1883	Livingston, W. J., London County Council, Spring-gardens, S.W.
Feb. 19, 1880	Trans. Lloyd, Alfred, The Dome, Bognor, Sussex
Feb. 3, 1876	Trans. Lloyd, F. J., Agricultural Laboratory, 4, Lombard-court, E.C.
May 4, 1893	Lloyd, Herbert, The Electric Storage Battery Co., Drexel Building, Philadelphia, U.S.A.
Feb. 16, 1871	Lockyer, William John, 7, St. Julian's Farm-road, West Norwood, S.E.
Mar. 20, 1884	London, J. Edward, M.D., 62, Main-street, George Town, Demerara
April 18, 1872	Longstaff, George Blundell, M.A., M.B. Oxon., M.R.C.P., Highlands, Putney Heath, S.W.
Feb. 20, 1873	Loram, H. Y., 19, Hillside-road, Stamford Hill, N.
Feb. 7, 1878	Trans. Louis, D. A., 77, Shirland-gardens, Maida Vale W.
May 4, 1882	Love, Edward G., Ph.D., 80, East 55th-street, New York, U.S.A.
June 15, 1882	Lovibond, Thomas Watson, F.I.C., The Tyne Brewery, Newcastle-on-Tyne
Dec. 18, 1884	Low, Charles William, M.B., Stowmarket
Dec. 15, 1856	Lowe, Charles, Summerfield House, Reddish, near Stockport
Feb. 21, 1878	Lowe, Walter Bezant, M.A., Stranraer School, Wickham, near Fareham, Hants
Feb. 3, 1876	Lowe, William Foulkes, A.R.S.M., 9, Hough-green, Chester
Dec. 6, 1888	Lowman, Oscar A. B., Ph.D.
Feb. 15, 1894	Lucas, E. W., 44, Kenilworth-road, Kilburn
Dec. 3, 1891	Ludlow, Lionel, Standard Bank of South Africa, Bulawayo, Rhodesia, and Southville, Swansea
Feb. 15, 1877	Trans. Luff, A. P., M.D., B.Sc. (Lond.), 31, Weymouth-street, Cavendish-square, W.
Mar. 6, 1890	Trans. Lumsden, John S., B.Sc., Ph.D. (Mun.), 5, Paradise-road, Dundee
Dec. 5, 1867	Trans. Lunge, Dr. George, Polytechnicum, Zürich, Switzerland
Dec. 4, 1890	Trans. Lunt, Joseph, B.Sc., 46, Arlington-road, Castle Hill, Ealing
Dec. 5, 1872	Trans. Lupton, Sydney, A. Audley Mansions, 44, Mount-street, W.
Feb. 30, 1894	Luty, Arthur, 9, Bryn-y-Mor-crescent, Swansea
Feb. 16, 1893	Trans. Luxmoore, Charles M., D.Sc., Alfred Cottage, Harpenden

Date of Election.		
May 1, 1873		Lyon, J. B., Brigade Surgeon, East India, U.S. Club, 16, St. James's-square, S.W.
Feb. 19, 1874		Lyon, J. G., The Aire Tar Works, Knottingley, Yorks
Nov. 18, 1886	Trans.	Lyons, Albert Brown, A.M., M.D.
Feb. 3, 1859		Lyte, F. Maxwell, M.A., Cantab., F.I.C., A.I.C.E., 60, Finborough-road, Kensington, S.W.
June 20, 1878		Macadam, C. T., 61, Brixton-hill, S.W.
Feb. 21, 1853		Macadam, Stevenson, Ph.D., F.R.S.E., Surgeons' Hall, Edinburgh
Feb. 2, 1888		Macadam, Stevenson, J.C.G., jun., Surgeons' Hall, Edinburgh
April 4, 1878		Macadam, W. Ivison, F.R.S.E., Professor New Veterinary College, Surgeons' Hall, Edinburgh
Dec. 2, 1886		Macan, Hugh, M.A., County Hall, Kingston-on-Thames
April 17, 1890		MacArthur, J. Stewart, 12, Knowe-terr., Pollokshields, Glasgow
Feb. 15, 1894		Macdonald, A. H., 11, Oriol-place, Bath-road, Cheltenham
Dec. 6, 1894	Trans.	MacDonald, G. W., B.Sc., 10, Hilgrove-road, N.W.
May 7, 1891		MacDonald, William, Tung Wen Kwan, Imperial Coll., Pekin
Mar. 4, 1886		MacEwan, Peter, 4, Gresley-road, Hornsey-lane, N.
June 18, 1891		Macfie, R. A. Scott, M.A. (Cantab), B.Sc., Rawcliffe R.S.O., Yorks
Feb. 21, 1895		MacFarlane, Alex., 149, Manx-terrace, Blackley, Manchester
Dec. 2, 1880		Macfarlane, James A., Vanconver, B.C.
Mar. 6, 1890		Macintyre, Alfred E., St. John's, N.B., Canada
Dec. 2, 1887		Mackay, Angus, Technical College, Ultimo, Sydney, N.S.W.
Dec. 2, 1886		Mackay, J. B. L., Prof. A.K.C.L.,
Dec. 4, 1890		Mackean, William, 14, Palmer-street, Westminster, S.W.
Dec. 3, 1874		Mackenzie, D. C., 106, Leadenhall-street, E.C.
Feb. 18, 1892		Mackenzie, Dr. William Cossar, Tewfikieh College of Agriculture, Ghizeh, Cairo
Jan. 15, 1844		MacLagan, Douglas, Sir, M.D., F.R.S.E., University of Edinburgh, and 28, Heriot-row, Edinburgh
Feb. 17, 1881		MacMunn, Charles A., M.A., M.D., F.R.M.S., Oakleigh, Wolverhampton
Feb. 1, 1880		Macnab, William, 14, Great Smith-street, Westminster, S.W.
June 4, 1885	Trans.	Macnair, Duncan Scott, Ph.D., B.Sc., 2, Grosvenor-terrace, Hillhead, Glasgow
April 19, 1888		MacSwiney, E., 13, North Main-street, Cork
Feb. 6, 1890		MacTaggart, James Guthrie
April 21, 1864	Trans.	Mactear, James, F.R.S.E., 2, Victoria-mansions, Westminster, S.W.
May 1, 1862	Trans.	Madan, H. G., Bearland House, Gloucester
June 21, 1888	Trans.	Maiden, Joseph Henry, Curator, Technological Museum, Sydney, N.S.W.

Date of Election.

May 5, 1892		Major, George Harry, Devonshire-street, Ardwick, Manchester
Dec. 6, 1894		Makin, C. J. Shaw, c/o Prof. L. R., Fresenius, 11, Kapellen-str., Wiesbaden
May 7, 1885		Mallet, F. R., 18, The Common, Ealing, W.
Dec. 17, 1857	Trans.	Mallet, J. W., Ph.D., M.D., F.R.S., University of Virginia, Albemarle Co., Va., U.S.N.A.
Feb. 4, 1858		Manning, F. A., 18, Billiter-street, E.C.
Feb. 7, 1853	Trans.	Marcet, W., M.D., F.R.S., Flowermead, Wimbledon Park, S.W.
May 16, 1895		Marchant, Robert Charles, M.R.A.S.E., M.R.A.C., Penrose Villa, Tutshill, Chepstow
Feb. 16, 1893		Marsden, Fred, Ph.D., Bangor, North Wales
May 16, 1895		Marsden, Prosper, Royal Infirmary, Liverpool
June 16, 1881		Marsh, Charles W., Ph.D.
Feb. 15, 1883	Trans.	Marsh, J. E., M.A., University Museum, Oxford
Feb. 21, 1895		Marshall, Arthur, 65, Fairholme-road, West Kensington
Feb. 6, 1890	Trans.	Marshall, Hugh, D.Sc., F.R.S.E., Chemical Department, University of Edinburgh
Dec. 3, 1891		Marshall, John Willis, Ph.D., M.Sc., Lancaster College, Morecambe
Feb. 19, 1891		Marshall, Reginald Tom, 60, Gracechurch-street, E.C.
Nov. 20, 1890	Trans.	Marshall, T. Rhymer, D.Sc., Chemical Laboratory, St. Mungo's College, Glasgow
Dec. 6, 1888	Trans.	Marshall, William, c/o D. G. Rose, Esq., Samarang, Java
June 16, 1887		Marshall, William, F.I.C., 149, Drake-street, Rochdale
June 15, 1893		Martin, Alexander Mitchell, Douglas-villa, Dunbeth-road, Coat-bridge
Nov. 19, 1885		Martin, Lieut.-Col. Gerald Ward, F.R.G.S., H.M. Mint, Bombay
Dec. 6, 1883		Martin, W. H., 183, King's-road, Chelsea, S.W.
Feb. 16, 1893		Martin, William J., jun., M.D., University of Virginia, Charlottesville, Va., U.S., N.A.
Feb. 19, 1891		Martin, William Morley, 16, Penryn-street, Redruth, Cornwall
April 7, 1870		Martindale, William, 10, New Cavendish-street, W.
June 1, 1871		Martineau, George, 21, Mincing-lane, E.C.
Dec. 1, 1887		Martineau, Sydney, South-road, Clapham-park, S.W.
June 2, 1851	Trans.	Maskelyne, Nevil Story, F.R.S., Salthrop, Wroughton, Wilts
Mar. 2, 1871		Mason, Alfred Henry, F.R.M.S., Seabury Building, 59, Maiden-lane, New York City, U.S.A.
Feb. 6, 1890		Mason, Francis H.
Mar. 4, 1893		Mason, James, M.D., Otaki, N.Z.
Nov. 4, 1858		Mason, James, Eynsham-hall, near Witney, Oxon
Dec. 5, 1889		Mason, James Braik, 2, Balgay Avenue, Dundee
Dec. 2, 1880		Mason, William Brandwood, 117, Derby-street, Bolton

Date of Election.

Jan. 19, 1882	Trans.	Masson, Orme, M.A., D.Sc., Prof. the University of Melbourne, Victoria
Dec. 4, 1873		Masters, William, Sub-Deputy Opium Agent, Gya, Bengal, India, and 82, Oxford-gardens, Notting Hill, W.
June 15, 1876	Trans.	Matthey, C. G., St. John's Lodge, Beckenham
June 17, 1880	Trans.	Matthews, Francis Edward, Ph.D., Royal Indian Engineering College, Cooper's Hill, Staines, and The Pines, Edglefield Green
Dec. 1, 1887		Matthews, Wm. Edward, Prof., The Stawell School of Mines, Stawell, Victoria, Australia
Jan. 17, 1884		Matthey, Edward, 78, Hatton-garden, E.C.
May 3, 1870		Matthey, George, F.R.S., 78, Hatton-garden, E.C.
Dec. 7, 1893		Mawer, William Frederick, 325, Kennington-road, S.E.
Dec. 7, 1865		Maxwell, Theodore, B.A., M.D. Camb., B.Sc. Lond., 29, Woolwich-common, S.E.
June 7, 1888		Mayhew, E. W. A.
Dec. 1, 1887		McArthur, John, F.R.S.E., 196, Trinity-road, Wandsworth-common, S.W.
Feb. 2, 1888		McBretney, Edmund G., Pontefract-road, Castleford, York
Feb. 6, 1890		McConnell, Arthur H., 35, Bernard-street, Russell-square, W.C.
Feb. 4, 1875		McCowan, William, F.I.C., 207, King's road, Reading
Dec. 5, 1895		McCreath, T., 4, Lombard-court, E.C.
Nov. 20, 1890		McCubbin, William A., 11, Orange-court, Castle street, Liverpool
Dec. 6, 1894		McCutcheon, Jas., Marchmont, Lanark
Dec. 17, 1857		McDougall, Alexr., 61, Liverpool-road, Birkdale, Southport
Dec. 17, 1874		McDougall, John, Clifton House, Greenwich-park, S.E.
June 15, 1893		McElroy, K. P., 1412, 16th-street, Washington, D.C., U.S.A.
Feb. 18, 1892		McFall, J. E. Whitley, Bankfield-road, West Derby, Liverpool
May 16, 1895		McGlashan, T., Sugar Works, Cawnpore
Mar. 3, 1887	Trans.	McGowan, George, Ph.D., 1, Mount-avenue, Ealing
May 4, 1893		McGregory, Joseph Frank, Prof., Hamilton, New York, U.S.A.
June 15, 1893		McKerrow, Charles Alexander, 18, Exchange-street, Manchester
May 5, 1892		McKerrow, William James, D.Sc., Messrs. Field and Co., Upper Marsh, Lambeth, S.W.
Feb. 6, 1868	Trans.	McLeod, Herbert, F.R.S., Indian Civil Engineering College, Cooper's Hill, Staines
June 7, 1894		McLeod, Jas., 2, Gladstone-terrace, Paisley
Feb. 17, 1881		McMillan, Walter George, Metallurgical Laboratory, Mason College, Birmingham
April 4, 1889	Trans.	McMurtry, George Cannon, Wallaroo Smelting Works, Wallaroo, S. Australia
Feb. 21, 1895		McVey, W. B., 301, Saratoga-street, Boston, U.S.A.
Feb. 18, 1892		Meacham, Chas. Stephen, Pettridge, Maidstone
Feb. 16, 1871	Trans.	Meldola, Raphael, F.R.S., 6, Brunswick-square, W.C.
Feb. 21, 1895		Meldrum, Robt., Thorne Villas, Johnstone, N.B.

Date of Election.

Feb. 15, 1894		Melland, Godfrey, B.Sc., Univ. College, Nottingham
May 20, 1875		Melmore, Pattinson B., Chemical Laboratory, Maryport
Dec. 18, 1884		Mercer, Francis M., 89, Bishopsgate-street-within, E.C.
Dec. 5, 1889		Mercer, Thomas, Great Hey, Edenfield, near Bury, Lancashire, and Ring Bank Brewery, Edenfield, near Bury
May 7, 1891		Merrils, Frederick Johnson, 371, Glossop-road, Sheffield
April 20, 1876	Trans.	Messel, Rudolph, Ph.D., 53, Ebury-street, S.W.
June 21, 1888	Trans.	Miers, Henry A., M.A., F.G.S., Magdalen College, Oxford
Feb. 18, 1892	Trans.	Millar, James Hill, c/o Mr. Horace Brown, 72, Chancery-lane, W.C.
Dec. 18, 1843		Millar, James,
Feb. 19, 1891		Millard, Edgar J., F.R.M.S., 40-42, Charlotte-street, Great Eastern-street, E.C.
Feb. 19, 1880	Trans.	Miller, A. K., Ph.D., Kilvert's-buildings, Withy-grove, Man- chester
Feb. 21, 1889		Miller, Harry East, Ph.D., 1264, Fourteenth-street, Oakland, California
April 4, 1889	Trans.	Miller, James Bruce, A.I.C., Rubislaw Den, North Aberdeen
Dec. 1, 1887		Miller, John A., Niagara University, Buffalo, New York
May 7, 1885	Trans.	Miller, N. H. J., Ph.D., Harpenden, Hertfordshire
June 15, 1893	Trans.	Mills, Charles, 21, St. Mary Abbotts-terrace, W.
Dec. 18, 1862	Trans.	Mills, E. J., D.Sc., F.R.S., Young Professor of Technical Chemistry in the Glasgow and West of Scotland Technical College, 60, John-street, Glasgow
May 7, 1885		Milne, Alexander, M.A., M.B., Assay Master, Bombay Mint, Bombay
June 21, 1877		Milne, G. A., Chemical Laboratory, 18, John Brown-street, Bolton
May 5, 1892		Milnes, Ernest E., 16, Ashfield, Bradford
Dec. 1, 1887		Mingaye, John C. H., Department of Mines, Assay Branch, Sydney
May 7, 1891	Proc.	Mitchell, Charles Ainsworth, B.A. Oxon., 11, Hubert's-grove, Clapham, S.W.
June 18, 1891		Mitchell, Thomas, c/o E. Mitchell, Esq., Crossmount, Bridgend, Perth, N.B.
Feb. 16, 1893		Mole, H. Bloome, Hill Side, Shepton Mallet
Feb. 15, 1872	Trans.	Mond, Ludwig, F.R.S., 20, Avenue-road, St. John's-wood, N.W.
Feb. 18, 1892		Mond, Robert Ludwig, M.A., F.R.S.E., The Poplars, 20, Avenue- road, Regent's Park, N.W.
Dec. 18, 1879		Mondy, Edmund F., Dacca College, Dacca, Bengal
May 4, 1893		Monson, Henry John,
Mar. 3, 1887	Trans.	Moody, G. Tattersall, D.Sc., Lorne House, North Dulwich, S.E.,
May 5, 1892		Moor, Cresacre George, B.A., State Med. Lab., King's College, Strand, W.C.
Feb. 19, 1891		Moore, Frederick Herbert, Strada degli Argentieri, 19, Messina, Sicily

Date of Election.		
Mar. 6, 1896		Moore, Ira, Ph.D., 64, Mottram-road, Hyde, near Manchester
Dec. 15, 1892		Moorwood, Francis Colin, 260, Barnsley-road, Sheffield
Dec. 5, 1895		Morgan, D. J., 10, Northampton-place, Swansea
Jan. 7, 1888		Morgan, John James, Riverdale, Abergavenny, Mon.
Dec. 7, 1893		Morgan, J. R., 57, Coldstream-street, Llanelly
June 17, 1880	Trans.	Moritz, Edward R., Ph.D., 72, Chancery-lane, W.C.
Dec. 18, 1879	Trans.	Morley, H. Forster, M.A., 47, Broadhurst-gardens, South Hampstead, N.W.
May 16, 1895	Trans.	Morrell, R. S., M.A., Ph.D., Gonville and Caius College, Cambridge
May 5, 1892		Morris, Albert, Fern Bank, Dunkinfield
Feb. 19, 1880	Trans.	Morris, G. Harris, Ph.D., 72, Chancery-lane, W.C., and 18, Gwendwr-road, West Kensington, W.
Dec. 3, 1891		Morris, Joseph, Stamford-street, Mossley, near Manchester
Nov. 4, 1869		Morrison, John, Chemical Engineer, St. Peter's Chemical Manure Works, Newcastle-on-Tyne
May 7, 1891		Morrison, George R., Richmond House, Plaistow, Essex
June 20, 1895		Morrison, J., Colonial Sugar Refining Company, O'Connell-street, Sydney
June 20, 1889		Morrow, Henry W., M.S., Ph.D.
Dec. 15, 1851		Morson, Thomas, 124, Southampton-row, Russell-square, W.C., and 42, Gordon-square, W.C.
Feb. 16, 1872		Morton, Edward Handfield, Campayne-mansions, Campayne-gardens, South Hampstead
Dec. 7, 1893		Morton, Frederick, 101, Quarmby-road, Huddersfield
Feb. 7, 1884		Morton, Percy, Christ College, Brecon, South Wales
April 17, 1890	Trans.	Mosenthal, Henry de, 220, Winchester House, Old Broad-street, E.C.
Jan. 19, 1871		Moss, John, 39, Tressillian-road, St. John's, S.E.
Jan. 19, 1871		Moss, Richard J., F.I.C., St. Aubyn, Ballybrack, Co. Dublin
Dec. 2, 1880		Mott, H. A., Ph.D., 63, West 45th-street, New York
April 15, 1886		Moul, Frank, Aldersgate Chemical Works, Southall
Feb. 16, 1884		Moyle, R. E., M.A., Heightley, Chudleigh, Devon
June 19, 1884	Trans.	Mueller, Baron Ferdinand Von, K.C.M.G., M.D., Ph.D., F.R.S., Melbourne
Jan. 17, 1889		Muir, James, The Yorkshire College, Leeds
Feb. 16, 1871	Trans.	Muir, M. M. Pattison, M.A., Fellow and Prælector in Chemistry, Gonville and Caius College, Cambridge
Mar. 30, 1870		Muirhead, Alexander, D.Sc., The Lodge, Shortlands, Kent
Feb. 3, 1859	Trans.	Müller, Hugo, Ph.D., F.R.S., 110, Bunhill-row, E.C.: and 13, Park-square East, Regent's Park, N.W.
May 4, 1893		Munby, Alan E., Felstead School, Essex
Mar. 15, 1888		Munroe, Charles E., Prof. Columbia University, Washington, D.C., U.S.A.

Date of Election.

Dec. 7, 1871		Munro, Donald, M.D., C.M., D.P.H., Medico Legal Department, University of Glasgow
Feb. 17, 1876	Trans.	Munro, J. M. H., D.Sc., Churchfields, Salisbury
May 4, 1893		Murray, J. Alan, 5, Caergog-terrace, and University College of Wales, Aberystwyth
Feb. 15, 1894		Murray, John Moore, Esq., Municipal Technical School, Arundel-street, Portsmouth
Jan. 21, 1869		Muspratt, E. K., Seaforth-hall, near Liverpool
Dec. 3, 1873		Muspratt, Sidney Knowles, 24, Grove-park, Liverpool
Dec. 4, 1890	Trans.	Murray, Thomas Smith, D.Sc., Chemical Department, Marischall College, Aberdeen
Nov. 3, 1870	Trans.	Muter, John, M.A., Ph.D., F.R.S.E., F.I.C., Laboratory, 325, Kennington-road, London, S.E., and Winchester-house, Kennington-road, S.E.
Dec. 4, 1890		Myers, Harry C., Ph.D., University of Washington, Seattle, Wash., U.S.A.
Feb. 18, 1892	Trans.	Myers, William Shields, B.Sc., 98, Easton-avenue, New Brunswick, U.S.A.
Mar. 6, 1890		Myles, John, M.A., B.Sc., Principal, Reinet College, Cape Colony
Feb. 3, 1887		Nagel, David Henry, M.A., Trinity College, Oxford
Mar. 5 1874		Napier, Arthur S., c/o Herren Mayer & Müller, 51, Markgrafen-strasse, Berlin, W., Germany
June 21, 1877		Napier James, 89, London-road, Ipswich
June 15, 1893		Napier, John Watson, Gas Works, Auchterarder, N.B.
Dec. 5, 1878		Napper, Edward W., The Hollies, Vicarage-laue, Bowden
Dec. 3, 1891		Naylor, William, 16, Walton's-parade, Preston
April 4, 1878		Naylor, W. A. H., 38, Southwark-street, S.E.
Dec. 3, 1891		Neilson, Thomas
Dec. 5, 1889		Nettleton, J. A., 2, Barrows-terrace, The Mount, Belfast
April 4, 1878	Trans.	Nevile, R. H. C., Crown Lea, Malvern
June 1, 1871	Trans.	Nevill, Edmund Neville, Gov. Lab., Durban, Natal
April 17, 1890	Trans.	Neville, Francis Henry, Sidney College, Cambridge
June 16, 1892		Newall, John Fenton, 8, Market-place, Manchester
June 4, 1885		Newbolt, Francis George, 1, Mitre-court-buildings, E.C.
April 19, 1860	Trans.	Newlands, John A. R., Laboratory, 27, Mincing-lane, E.C.
Feb. 18, 1864		Newlands, B. E. R., 11, Dunsmure-road, Stamford Hill, N.
Dec. 3, 1891		Newlands, William, P. R., 1, Mildenhall-road, Lower Clapton, N.E.
April 4, 1889		Newsholme, G. T. Wilkinson, 74, Market-place, Sheffield
June 7, 1894		Newth, G. S., Royal College of Science, South Kensington
May 16, 1895		Newton, C. B., Gas Works, Carlisle

Date of Election.		
Dec. 18, 1879		Newton, Howard
Mar. 4, 1886		Newton, Walter, Beech Villa, Park-lane, Macclesfield
Mar. 1, 1883		Newton, William, Ph.D., F.I.C., 39, Mincing-lane, London, E.C.
Dec. 15, 1892		Nickolls, J. Bate, The Laboratory, Guernsey
Feb. 16, 1870	Trans.	Nicholson, Edward, Brigade Surgeon, 41, Sandy-road, Seaforth, Liverpool
June 4, 1885	Trans.	Nicholson, T. Goddard, M.B. Lond., B.Sc., M.R.C.S., L.R.C.P. 9, Cleveland-row, St. James', S.W.
Dec. 5, 1889		Nickels, Wallace Christopher, 14, Yew-grove, Cricklewood, N.W.
Feb. 1, 1883	Trans.	Nicol, W. W. J., 15, Blacket-place, Edinburgh
June 7, 1894		Nixon, Alf., General School, Deansgate, Manchester
May 6, 1869		Noble, Captain Sir A., Engineer, Elswick Ordnance Works, Newcastle
Dec. 5, 1889		Norman, John T., Avalon, Putney Common, S.W.
April 4, 1861		Norrington, Frederick, 5, Downfield-road, Clifton, Bristol
June 16, 1892		Norris, Charles James, 24, Ravenscourt-gardens, Hammersmith
May 5, 1892		Northing, John, The Murrough, Wicklow
Dec. 18, 1854		Norton, Fletcher, Longtown, Abergavenny
April 4, 1878		Norton, Prof. T. H., Ph.D., University of Cincinnati, Ohio, U.S.A.
June 18, 1891		Notter, J. Lane, M.A., M.D., West Cliff, Woolstone, Southampton
May 4, 1893	Proc.	Oates, William Henry, Broomhall Park, Sheffield
Mar. 4, 1886		Obach, Eugene, Ph.D., F.I.C., 2, Victoria-road, Old Charlton, Kent
May 15, 1890		Oddy, Robert Walter, Waterhouse, Toad-lane, Rochdale
Jan. 19, 1873		Odling, Walter, 132, High-street, and at Messrs. Bass & Co., Burton-on-Trent
Jan. 17, 1848	Trans.	Odling, William, M.B., F.R.S., 15, Norham Gardens, Oxford
May 4, 1871		Ogston, G. H., Analytical Laboratory, 39, Lime-street, E.C.
Dec. 2, 1875		Oman, J. Campbell, Prof., Government College, Lahore, Punjab, India
June 20, 1889		O'Mahony, D. J., Municipal-buildings, Cork
Dec. 4, 1890	Trans.	Ormandy, Wm. Reginald, c/o W. Ormandy, 17A, King-street, Wigan
Nov. 4, 1869		Orme, Temple A., University College, W.C.
May 16, 1872		Ormerod, Joseph Arderne, M.B., M.R.C.P., The Library, St. Bartholomew's Hospital, E.C.
Dec. 6, 1894		Ormerod, T., Sackville-street, Burnley, Lanes.
Dec. 1, 1887		Ormiston, Archibald R., Heathland, Uddingston; and 203, St. Vincent-street, Glasgow
June 15, 1893		Orr, Alexander, 109, Pitt-street, Sydney, Australia

Date of Election.

Feb. 21, 1884	Proc.	Orsman, W. J., jun., The Roburite Explosives Co., Gathurst, near Wigan
Mar. 17, 1881	Trans.	O'Shea, L. Trant, Firth College, Sheffield
Dec. 1, 1887		Ostersetzer, Julius, Messrs. W. and H. M. Goulding, Manure Manufacturers, Dublin
April 20, 1876	Trans.	+O'Sullivan, C., F.R.S., 140, High-street, Burton-on-Trent
Mar. 1, 1883	Trans.	O'Sullivan, James, 26, Ashby-road, Burton-on Trent
Mar. 17, 1887		O'Sullivan, Patrick T., M.B., B.C.L., 34, South Mall, Cork
May 7, 1891		Ough, Lewis, Curzon-terrace, Sparkenhoe-street, Leicester
Feb. 16, 1888		Overbeck, Otto C. J. G. L., Chantry House, Great Grimsby
June 16, 1887		Overend, Fred. Lawrence, B.A. (Oxon), Royal Grammar School, Sheffield
Feb. 16, 1893		Owen, Robert Henry, Bush Hotel, Dowlais
Dec. 15, 1851		Oxland, Robert, Dr., 32, Portland-square, near Plymouth
Dec. 21, 1871	Trans.	Page, Frederick James Montague, B.Sc., 54, Sutherland-street Pimlico, S.W.
Jan. 17, 1884		Pallister, J. W., B.Sc., 22, Grimthorpe-terrace, Headingley, Leeds
May 4, 1882		Palmer, Alfred Neobard, Inglenook, Bersham-road, Wrexham
Nov. 19, 1868	Trans.	Palmer, Dr. W. J., 32, Bassett-road, W.
April 19, 1888		Palmer, Henry John, Carlisle House, Knowle-road, Bristol
April 17, 1879		Palmer, Walter, Westfield, Reading
Jan. 19, 1882		Parker, Joseph R., Avondale, Beaver-road, Ashford
May 3, 1894		Parker, Matt. A., 13, Hamilton-crescent, Partick, Glasgow
Dec. 7, 1882		Parker, R. H., 35, Clifton-road, Maida Vale, W.
Nov. 20, 1890		Parkes, Thomas, M.A., 30, Hopwood-street, Barnsley
Nov. 2, 1865	Trans.	Parkinson, James, F.G.S., Queen's-chambers, Pirie-street, Adelaide, South Australia
May 4, 1893		Parrish, S., 1, Highfield-terrace, Kingston-road, Leeds
Feb. 18, 1892		Parry, Ernest John, B.Sc. 71, Woodside-green, S.E.
May 17, 1888		Parsons, William, Dispensary, St. Bartholomew's Hospital, E.C.
April 21, 1870		Patchett, Isaac, F.I.C., 1, Leopold-square, Leeds
Feb. 15, 1894		Paterson, David, Lea Bank, Roslin, N.B.
Mar. 5, 1885	Trans.	Patterson, George, The Manbré Saccharine Co., Hammersmith, W.
May 16, 1895		Patterson, L. G., Washington Carbon Company, Washington, Pa.
Mar. 17, 1870	Trans.	Patterson, T. L., c/o Messrs. John Walker and Co., Greenock
Dec. 3, 1863	Trans.	Pattinson, John, 75, The Side, Newcastle-upon-Tyne
Mar. 5, 1868	Trans.	Paul, Dr. B. H., Analytical Laboratory, 20, Victoria-street, Westminster, S.W.
Dec. 3, 1885	Trans.	Paul, Lewis Gordon, Ph.D., Messrs. Read, Holliday and Sons, Huddersfield

† Longstaff Medallist, 1884.

Date of Election.

Feb. 15, 1894		Paulusz, Richd., Royal Colonial Institute, Northumberland-avenue, W.
Dec. 7, 1893		Payne, George, F.M.D., Atlanta, Georgia, U.S.A.
Feb. 15, 1894		Pearson, William Henry, 6, Fenchurch-buildings, E.C.
Jan. 16, 1874	Trans.	Pearce, William, jun., Chemical Works, Bow Common, E.
Feb. 15, 1894		Peden, John, jun., Chemical Laboratory, 11, Duff-street, Greenock
Feb. 4, 1870	Trans.	Pedler, Alexander, Prof., F.R.S. Presidency College, Calcutta
May 20, 1886	Proc.	Pendlebury, William Henry, M.A., 6, Gladstone-terrace, Dover
Mar. 7, 1870		Penney, M. D., 11, High-street, Hull
Dec. 5, 1895		Pennington, W. H., Field House, Rochdale
Dec. 16, 1886		Pentecost, Stephen James, Nottingham-road, New Basford, Nottingham
Jan. 17, 1889	Trans.	Percival, John, M.A., S.E. Agric. Coll., Wye, near Ashford
April 17, 1884	Trans.	Perkin, A. G., 8, Montpelier-terrace, Hyde Park, Leeds
June 18, 1891	Trans.	Perkin, Frederick M., Cheml. Laborat. Univer. of Würzburg, Würzburg, Bavaria
Dec. 15, 1856	Trans.	† Perkin, W. H., Ph.D., F.R.S., The Chestnuts, Sudbury, Harrow
April 17, 1884	Trans.	Perkin, W. H., jun., F.R.S., Fairview, Wilbraham-road, Fallow-field, Manchester
Feb. 6, 1890	Trans.	Peiman, Edgar Philip, D.Sc., University College, Cardiff
Dec. 6, 1888		Perry, George Edward, 6, Norwood-villas, Edgbaston, Birmingham
June 16, 1881		Philip, Arnold, A.R.S.M., B.Sc. Lond., F.I.C., Heriot-Watt College, Edinburgh
Feb. 1, 1887		Phillips, A. G., 18, Popstone-road, Kensington, S.W.
June 20, 1889		Phillips, Benjamin, Victoria House, Byculla, Bombay
Feb. 16, 1882		Phillips, Henry Harcourt, 183, Moss-lane East, Manchester
Feb. 21, 1889		Phillips, Henry Joshua, Palace-chambers, Westminster, S.W.
Feb. 19, 1891		Pickering, M. Samuel, B.Sc., Lond., 38, Price-street, Burslem
Feb. 7, 1878	Trans.	Pickering, Spencer Percival Umfreville, M.A., F.R.S., 48, Bryanston-square, W., and Harpenden, Herts
April 17, 1890	Trans.	Picton, Harold, B.Sc., 3, Reighton-road, Upper Clapton
June 7, 1894		Pike, E. Brookes, 6, Harrow-villas, East Ham, Essex
Jan. 15, 1874	Trans.	Pike, William Herbert, Ph.D., University, Toronto, Canada
Dec. 20, 1883		Pilley, John J., Ph.D., 167, Camberwell Grove, S.E.
Dec. 5, 1889		Ping, William, 2, Sandbourne-road, Brockley, S.E.
Feb. 21, 1889		Pingstone, G. Arthur, The Goldfields of Matabele Land, Limited, Bulawayo, Rhodesia, S.A.
Mar. 17, 1881		Pisani, O. V., Gibraltar-house, Rochmount-road, Upper Norwood
Feb. 16, 1882		Pitt, Theophilus, 16, Coleman-street, E.C.
Feb. 16, 1893		Platt, Charles, Ph.D., Hahnemann Med. Coll., Philadelphia, U.S.A.

† Longstaff Medallist, 1888.

Date of Election.

April 4, 1889		Platts, John Charles, Ryecroft Glen, near Dore Station, Sheffield
Nov. 15, 1860		Player, J. H., 16, Prince Arthur-road, Hampstead, N.W.
Feb. 23, 1841	Trans.	* Playfair, Right Hon. Lord, K.C.B., F.R.S., 68, Onslow-gardens, South Kensington
Dec. 2, 1880	Trans.	Plimpton, R. T., Ph.D., 23, Lansdowne-road, Clapham-road, S.W.
June 7, 1888		Pollard, F. Ernest, Old Cross, Hertford
Feb. 15, 1894		Pollok, J. Holms, Royal College of Science, Dublin
Dec. 4, 1890		Pond, James Alexander, Auckland, New Zealand
Dec. 4, 1848		Pontifex, Edmund A., M.I.C.E., 72, Cornwall Gardens, S.W.
Mar. 6, 1862		Pooley, Thomas A., B.Sc., F.I.C., 121, The Grove, Denmark Hill, S.E.
Feb. 19, 1891	Trans.	Pope, Wm. Jackson, Central Technical College, Exhibition-road, S.W., and 16, Barclay-road, Walham Green, S.W.
Dec. 18, 1884		Porter, T. Cunningham, Rev., Eton College, Windsor
Dec. 6, 1883		Potter, Charles E., c/o Messrs. Tate & Sons, Love-lane Sugar Refinery, Liverpool
Feb. 21, 1895		Powell, H. James, 530, Lordship-lane, S.E.
Feb. 21, 1884		Power, Francis R., The Royal Mint, Melbourne
April 15, 1880		Preller, Charles S. Du Riche, M.A., Ph.D., A.M.I.C.E., F.G.S., 18, Margaret-street, Cavendish-square, W.
May 19, 1864		Prentice, Manning, Woodfield, Stowmarket
Mar. 2, 1876	Trans.	Prescott, Albert B., M.D., University, Ann Arbor, Michigan, U.S.A.
May 16, 1861		Prestwich, Joseph, F.R.S., Shoreham, Sevenoaks, Kent
Dec. 5, 1872	Trans.	Prevost, E. W., Ph.D., Elton, Newnham, Gloucester
May 4, 1882		Price, Arthur F., 524, Sacramento-street, San Francisco
Dec. 5, 1895	Trans.	Priest, Martin, Apothecaries Hall, Blackfriars. E.C.
Jan. 17, 1889		Priestley, Charles W., B.Sc., Vivian Institute, Torquay
Dec. 3, 1891		Priestley, Lawrence, Newark-on-Trent
Feb. 17, 1870		Pritchard, Prof. William, President Royal Veterinary College, N.W.; and 5, Regent's Park-road, Gloucester-gate, N.W.
June 15, 1871	Trans.	Procter, Henry R., F.I.C., The Yorkshire College, Leeds
April 4, 1889		Proctor, Charles, Upland House, 359, Upland-road, Dulwich, S.E.
Jan. 17, 1889		Provis John, Zeehan, Tasmania
June 15, 1882		Pullar, Rufus D. Ochil, Kinnoul, Perth
Feb. 18, 1892	Trans.	Pullinger, William, B.A., Ash Lea, Romiley, Stockport
June 21, 1883		Purell, M. F., 41, Lower Bagot-street, Dublin
June 3, 1875	Trans.	Purdie, Thomas, F.R.S., Ph.D., B.Sc., Assoc. R.S.M. University, St. Andrews, N.B.
ec. 2, 1886		Pyke, L. S. M., A.M.I.C.E., M.I.C.E., F.R.I., 44, Kensington, Park-gardens, W.
Mar. 4, 1868		Quibell, Oliver, Magnus Lodge, Newark-on-Trent
Dec. 5, 1889	Trans.	Quincke, Frederick, Ph.D.,

Date of Election.

Dec. 6, 1894		Quinn, Gerald G., 16, Albert-street, Newcastle under-Lyme, Staffs.
Feb. 15, 1894		Quinn, J. Cardwell, Manor Rubber Mil's, Aston Cross, Birmingham
Dec. 15, 1892	Trans.	Ramage, Hugh, Royal College of Science, Dublin
Nov. 15, 1888		Ramsay, A. Alexander, Anan Villa, Rose-road, Auckland
Mar. 20, 1873	Trans.	Ramsay, W., Ph.D., F.R.S., University College, W.C., and 12, Arundel-gardens, Notting-hill, W.
May 7, 1891		Randall, Percy Morrice, 3, Belsize Park-gardens, N.W.
April 18, 1843		Randall, William B., 52, Archers-road, Southampton
Dec. 3, 1885		Ranken, Charles, Stockton-road, Sunderland
May 16, 1889		Ransom, Francis, 12, Bancroft, Hitchin
April 21, 1887		Rawlins, Edward, 114, Burley-road, Leeds
June 17, 1880		Rawson, Christopher, 2, Melbourne-place, Bradford
Jan. 17, 1884	Trans.	Rawson, Sidney George, D.Sc., Technical Schools, Huddersfield
April 4, 1889	Trans.	Read, Arthur A., 3, Fitzalan-place, Cardiff
June 20, 1895		Read, E. J., 8, Ravensdon-street, Kennington Park, S.W.
Nov. 20, 1890		Redding, Richard James, 17, Leghorn-road, Plumstead, S.E.
Jan. 15, 1874	Trans.	Reddrop, Joseph, Laboratory, L. and N.W. Ry., Crewe
July 16, 1892		Redman, Henry Ramsden, 150, Canterbury-road, New Brompton
June 20, 1889		Redwood, Robert, 4, Bishopsgate-street-within, E.C.
Jan. 18, 1866		Redwood, Boverton, F.R.S.E., 4, Bishopsgate-street-within, E.C.
Mar. 17, 1887		Redwood, T. Horne, 15, Red Lion-square, W.C.
Nov. 18, 1886	Trans.	Rée, Alfred, Ph.D., 1, Brighton-grove, Rusholme, Manchester
Dec. 7, 1893		Rees, George Percival, 60, Albert-street, Newcastle-under-Lyme
Nov. 16, 1882	Proc.	Reed, Lester, F.I.C., Hyrst-hof, 8, South Park-hill-road, Croydon, S.E.
April 15, 1880		Regeater, William, Lawn-lodge, Isleworth, Middlesex
Dec. 7, 1893		Reid, Thomas Anderson, Lostock, Gralam, Northwich
Dec. 15, 1881		Reid, Walter Francis, Fieldside, Addlestone, Surrey
June 17, 1886		Remington, J. Price, Prof., 1832, Pine-street, Philadelphia, Pa., U.S.A.
Feb. 6, 1879	Trans.	Rennie, Edward H., Ph.D., University of Adelaide, S. Australia
May 17, 1888	Trans.	Reynolds, Colonel Henry Charles, Thornclyff, Sandown-road, Cheltenham
June 19, 1873	Trans.	Reynolds, James Emerson, Prof., F.R.S., Trinity College, Dublin
Nov. 19, 1857		Reynolds, Richard, 13, Briggate, Leeds
June 18, 1891		Rhodes, Edward, Highfields, Frodsham, Cheshire
May 18, 1876		Richards, D. H., Bryntirion, Oswestry
April 4, 1889		Richards, Duncan T., 3, Madeira-terrace, Westoc-lane, South Shields
Jan. 17, 1889		Richards, Edgar, 1621, H. Street, Washington, D.C., U.S.A.
Jan. 17, 1889		Richards, Percy A. E., F.I.C., 12, Wolverton-gardens West, Kensington, W.

Date of Election.	
June 17, 1886	Richards, William, B.Sc., The Clock House, Tooting, S.W.
May 5, 1892	Richardson, Albert Ernest, Wycliffe Hall, Oxford
June 18, 1885	Trans. Richardson, Arthur, 22, Meridian-place, Clifton, Bristol
Feb. 16, 1888	Trans. Richardson, Clifford, Laboratory, Barber Asphalt Co., Long Island City, New York, U.S.A.
Feb. 1, 1883	Richardson, F. W., 2, Farclyffe-place, Bradford
Mar. 6, 1873	Richardson, Henry, Lyndene, Hale-road, Bowdon, Cheshire
Dec. 6, 1888	Richardson, Hubert N. B., The Hawthorns, Knighton Park-road, Leicester
April 19, 1866	Richardson, Joseph, jun., 40, Warwick-road, Chorlton-cum-Hardy, Manchester
Dec. 1, 1864	Richardson, J. G. F., Ph.D., Elmfield, Knighton, Leicester
May 5, 1892	Richardson, Reginald E. S., Elmfield, Knighton, Leicester
Nov. 17, 1887	Richardson, W. H., Dudley
Mar. 3, 1887	Trans. Richmond, H. Droop, 7, Cambrian-road, Richmond
Feb. 3, 1845	Rickard, W. T., 136, Maygrove-road, West Hampstead, N.W.
Dec. 6, 1894	Riddick, D. G., Stores Department, G.E.R., Stratford, E.
Dec. 7, 1882	Trans. Rideal, Samuel, D.Sc., F.I.C., 28, Victoria-street, Westminster, S.W.
April 3, 1873	Rider, Alonzo John, 4, Haddington-road, Stoke, Devonport
Dec. 5, 1895	Ridge, W. T. B., 2, Ashwood-terrace, Longton, Staffs.
Feb. 16, 1882	Trans. Ridsdale, C. H., Hutton-grange, Guisbrough, Yorks
Dec. 6, 1888	Rigby, John S., 35, Bagot-street, Wavertree, Liverpool, and Ditton, Lancashire
Dec. 15, 1851	Trans. Riley, Edward, 14A, Finsbury-square, E.C.
Dec. 4, 1873	Rimmington, F. M., Bradford
May 4, 1893	Rintoul, William, Royal Gunpowder Factory, Waltham Abbey
June 15, 1893	Ritchie, George, Bruce Villa, Mount Vernon, N.B.
May 4, 1893	Robbins, James H., 4, Selborne-road, Ilford
April 13, 1872	Robbins, John, 57, Warrington-crescent, Maida-vale, W.
June 20, 1889	Roberts, Emmanuel, M.D., Moratniva, Ceylon
June 21, 1883	Roberts, Frederick G. Adair, Warton-road, Stratford, E.
Jan. 20, 1876	Roberts, Martin Fenn, Postal Telegraph Factory, Mount Pleasant, Clerkenwell, E.C.
April 4, 1889	Roberts, R. Wightwick, c/o A. W. Rowe, Esq., Dashwood House, 9, New Broad-street, E.C.
May 3, 1894	Roberts, Thos. John, 31, North-road, St. Helens, Lancs.
Feb. 19, 1880	Roberts, W. Brittain, Wilderspool House, Warrington, Lancashire
Nov. 7, 1866	Trans. Roberts-Austen, William Chandler, C.B., F.R.S., Royal Mint, E.
Feb. 15, 1894	Robertson, A. B., Dangayne, Bearsden, by Glasgow and Technical School, Coatbridge
Mar. 17 1887	Robertson, George, London Hospital, and Madeira-villa, Woodford Green, Essex

Date of Election.		
Dec. 4, 1890	Proc.	Robertson, George Henry, 30, Hemstall-road, West Hampstead, N.W.
Feb. 21, 1889		Robins, Harry H., Messrs. Southwell and Co., Dockhead, S.E.
May 5, 1881		Robinson, G. Carr, Royal Institution, Hull
Nov. 16, 1882	Trans.	Robinson, Henry H., M.A., Wuchang, Hankow, China
Feb. 21, 1895		Robinson, H. Lewin, 9, Lloyd-street, W.C.
May 3, 1866		Robinson, John, The Hollies, Longlands-road, Sidcup
June 7, 1894		Robjohns, Herb. Harold, 7, Bay View-ter., Pwllheli, North Wales
Dec. 15, 1892		Robson, James, Andersonian-buildings, 204, George-st., Glasgow
Dec. 15, 1892	Trans.	Rodger, James Wyllie, 80, Anerley-park, S.E.
Dec. 20, 1883		Rogers, Arthur W., Tadcaster Tower Brewery Co., Tadcaster
Jan. 17, 1884		Rogers, Francis M., 21, Burma-road, Stoke Newington, N.
June 7, 1894		Rolfe, John F., Fern Bank, Clayton-le-Moors
April 15, 1886		Roose, Robson, M.D., 45, Hill-street, Berkeley-square, W.
Dec. 17, 1855	Trans.	Roseoe, Sir H. E., LL.D., F.R.S., 10, Bramham-gardens, South Kensington, S.W.
Feb. 19, 1891	Trans.	Rose, Tom Kirke, D.Sc., 9, Royal Mint, E.
Feb. 15, 1894		Ross, Arthur, 1, Glengall-road, Old Kent-road, S.E.
Feb. 17, 1870		Ross, Lewis Buttle, Driffield
Dec. 15, 1881		Ross, Rev. Henry, LL.D., Dallas House, Lancaster
June 18, 1891	Proc.	Rossiter, Edmund Charles, Sunnyfield, Vicarage-road, Langley, Birmingham
Feb. 20, 1896		Rostron, H., B.Sc., 70, Davenport-street, Bolton
Feb. 18, 1892		Rothewell, C. F. Seymour, 88, George-street, Moss Side, Manchester
Feb. 15, 1894		Rouillard, Richard A., 2, Springfield-road, Wimbledon, S.W.
Dec. 5, 1895		Round, W., 10, Northampton-street, Birmingham
Dec. 19, 1872		Routledge, Robert, B.Sc., The North-Eastern Railway Laboratory, Greenfield, Gateshead-on-Tyne
Feb. 15, 1894		Rowntree, Walter Smithson, 48, Grosvenor-road, S.W.
June 17, 1830		Roy, Taraprasanna, 68/6, Panchanantala-lane, Calcutta
Mar. 20, 1862		Royle, Thomas, 329, Upton-lane, Forest Gate, E.
Feb. 15, 1872	Trans.	Ruffle, John, Gnoll Brook, Neath, South Wales
Dec. 5, 1895		Rugginz, W. A., 11, Seiborne-road, Grange Estate, Ilford
Jan. 17, 1889	Trans.	Ruhemann, Siegfried, Ph.D., M.A., Gonville and Caius College, Cambridge
Feb. 15, 1883		Rumble, Charles, 9, Sangora-road, New Wandsworth
Feb. 20, 1896		Rutter, T. F., B.Sc., The Huish School, Taunton.
Feb. 6, 1890		Russell, Edward, 36, Lucerne-road, Highbury Park, N.
Mar. 3, 1851	Trans.	Russell, W. J., Ph.D., F.R.S., 34, Upper Hamilton-terrace, St. John's-wood, N.W.; and St. Bartholomew's Hospital, E.C.
June 7, 1894		Ryce, George, B.A., Rathmore-place, Cork
Feb. 16, 1870		Rylands, Thomas Glazebrook, F.L.S., Highfields, Thelwall, near Warrington

Date of Election.

June 7, 1888		Sach, A. J., Technical School, Goulburn, N.S.W.
Feb. 19, 1891		Sieré, Howard C., 5, Ecclesford-road, Pendleton
June 18, 1868		Sadler, S. A., Dr., Cleveland Chemical Works, Middlesborough
May 4, 1882		Sadtler, Samuel P., Ph.D., 145, North 10th-street, and 1042, Drexel-buildings, Philadelphia, U.S.A.
Feb. 20, 1896		Sage, C. E., 7, Oseney-crescent, N.W.
Dec. 20, 1883	Trans.	Saint, W. Johnston, Kurfuersten Strasse 5, Bonn-Poppelsdorf, Germany
June 19, 1879	Trans.	Sakurai, J., Science College, Imperial University, Tokyo, Japan
Feb. 19, 1880		Salamon, Alfred Gordon, 27, Holland-park, W.
May 4, 1876		Salomons, Sir David Lionel, Broomhill, Tunbridge Wells; and Berkeley Chambers, 13, Bruton-street, Hyde-park, W.
April 16 1863		Salt, Henry, M.D.C.M., F.R.G.S., Inglewood, Great Malvern
Feb. 17, 1859		Salter, Thomas W., 4, St. John's road, St. Leonard's
June 25, 1871		Salter, Mortyn John, Northcote, Beaconsfield-road, New Southgate
Feb. 20, 1896		Salt, A. P., Sunnyside, Pinner-road, Harrow
May 4, 1882		Simuel, W. Cobden, Wilton Lodge, 337, Norwood-road, West Norwood, S.E.
Mar. 3, 1870		Sandberg, C. P., 19, Great George-street, Westminster
Feb. 13, 1892		Sandcock, Thos. J. Buckler, Sideup College, Sideup, Kent
Dec. 6, 1888		Sanderson, John, P.O. Box 84, Middlesborough, Kentucky, U.S.A.
Nov. 16, 1882		Sanford, P. Gerald, Laboratory, 20, Cullum-street, E.C.
Dec. 4, 1890		Saniter, Ernest Henry, Laboratory, Wigan Coal and Iron Co. and 11, Market-street, Wigan
Dec. 3, 1891		Sanyal, Abhaya-haran, M.A., Professor of Physical Science, Queen's College, Benares, N.W.P., India
Dec. 15, 1892		Sarbadhicary, Sitya-prasad, 1, College-street Calcutta
June 17, 1886		Saunders, Prof. William, Experimental Farm, Ottawa, Ontario, Canada
Feb. 2, 1888		Saunders, W. Sedgwick, M.D., L.R.C.P. Ed., M.R.C.S., F.S.A., Medical Officer of Health for City of London, 13, Queen-street, Cheapside, E.C.
Feb. 6, 1890		Sayers, William Charles, 63, High-street, Lewisham, S.E.
Dec. 3, 1885		Seammell, Luther R., 42-4, King William-street, Adelaide, South Australia
June 21, 1877		Searf, Sydney Isaac, F.I.C., City of London College, White-street, Moorfields, E.C.; and 75, Oxford-road, Islington, N.
Feb. 6, 1873		Schacht, George Frederick, 1, Windsor-terrace, Clifton, Bristol
Dec. 7, 1893		Schidrowitz, Philip, Ph.D., 102, Oxford-gardens, Notting Hill
Dec. 6, 1888		Schieffelin, William Jay, 841, Southern-boul, New York, U.S.A.
Dec. 15, 1892	Trans.	Schloesser, Augustus, Ph.D., Storey Institute, Lancaster
Feb. 18, 1892		Schofield, James Alexander, University of Sydney, New South Wales

Date of Election.	
Mar. 15, 1842	Trans. Schunck, Edward, Ph.D., F.R.S., Oaklands, Kersal, Manchester
Dec. 6, 1894	Scorer, A. G. Flaxmoor, Caston, Attleborough, Norfolk
June 18, 1863	Scorgie, James, Poona Villa, King's Gate, Beechgrove-terrace, Aberdeen
Dec. 18, 1879	Scott, Alexander, M.A., D.Sc., Chemical Laboratory, University, Cambridge
April 17, 1890	Scott, Ernest George, 67, Lord-street, Liverpool
Mar. 3, 1887	Scrutton, W., Cue, W. Australia
Mar. 1, 1883	Proc. Scudder, Frank, 44, Mosley-street, Manchester
May 7, 1891	Scarl, Albert, Montrena, Victoria-road, Sidcup
Nov. 20, 1890	Seaton, Edward Cox, M.D., The Limes, 56, North Side, Clapham Common, S.W.
June 21, 1888	Seely, Herbert W., 11, Corn-market, Halifax
Dec. 15, 1892	Trans. Sell, William James, Univ. Chem. Laboratory, Pembroke-street, Cambridge
April 15, 1875	Sellon, J. Scudamore, The Hall, Sydenham, S.E.; and 78, Hatton gardens, E.C.
Feb. 16, 1882	Sells, V. Peironet, Highfield, New Headington, Oxford
Mar. 4, 1875	Trans. Senier, Alfred, Prof., M.D., Ph.D., Queen's College, Galway
June 21, 1887	Senier, Harold, Braybrook Lodge, Harrow
June 15, 1893	Sessions, Wilfred, B.Sc., Leighton Park School, Reading
an. 20, 1870	Trans. Seward, Henry, c/o Messrs. J. B. Freeman, Sons, and Co., Wandle Colour Works, Wandsworth, S.W.
Feb. 19, 1874	Sexton, A. Humboldt, F.I.C., F.R.S.E., Professor of Metallurgy, Metallurgical Department, Andersonian buildings, 204, George-street, Glasgow
Dec. 5, 1895	Seyler, C. A., 31, Windsor terrace, Swansea
June 20, 1880	Shadwell, J. E. L., Meadowbanks, Melksham, Wilts
Feb. 20, 1873	Shapleigh, Waldron, Welsbach Incandescent Gas Light Co., Factory, Gloucester City, New Jersey, U.S.A.
Dec. 7, 1893	Shapley, Frederick, 2637, Webster avenue, Fordham, New York
June 4, 1874	Sharman, William, 247, Marc-street, Hackney, N.E.
June 18, 1885	Sharp, James, The Towers, Low Moor, near Bradford
Feb. 21, 1895	Sharrott, T. C., 2, Margaretta-terrace, S.W.
Dec. 15, 1892	Shaw, G. Arthur, 45, St. Petersgate, Stockport
May 16, 1895	Shaw, G. E., 9, Basing-road, Westbourne-park, W.
Feb. 6, 1890	Trans. Shaw, Saville, Durham College of Science, Newcastle-upon-Tyne
June, 16, 1887	Sheard, John T., 282, Crook's-moor-road, Sheffield
April 4, 1889	Shegog, Thomas Alexander, 28, Omsbersley-road, West Park, Newport, Mon.
Feb. 17, 1876	Trans. Shens'one, W. A., Clifton College, Bristol; and 12, Clifton Park, road, Clifton, Bristol

Date of Election.

May 21, 1874		Shepherd, H. H. B., Northcote, Mount Pleasant-lane, Upper Clapton, N.E.
Dec. 15, 1892		Shepherd, Reginald des Forges, 6, Coltman-street, Hull
June 18, 1891	Trans.	Shields, John, Ph.D., D.Sc., 79, Balmoral-road, Willesden Green, N.W.
Dec. 16, 1886	Trans.	Shimidzu, T., 6641, Woodlawn-avenue, Chicago, U.S.A.
April 19, 1883		Shopoff, Vulko Ivan
June 7, 1894		Shorthouse, H. S., 47, Pershore-road, Birmingham
Nov. 18, 1886		Shutt, Frank, M.A., Experimental Farm, Ottawa, Canad
April 17, 1890		Shuttlewood, W. Brewin, 8, Clifton-road, Crouch End, N.
June 7, 1894		Shuttleworth, E. B., Prof., 220, Sherborne-street, Toronto
May 16, 1889		Sibson, Alfred Edward, 3, Osborne-road, Buckhurst Hill, Essex
Dec. 15, 1859		Sibson, Alfred, 23, St. Mary Axe, E.C.
Nov. 29, 1874	Trans.	Siebold, Louis, Broomville-avenue, Sale, near Manchester
Dec. 2, 1886		Silvester, Harry, Malvern House, Handsworth, Birmingham
Dec. 3, 1885		Sim, James, 77, Dee-street, Aberdeen
April 4, 1889		Simmonds, Henry, Gas Works, Colue, Lancashire
April 21, 1887		Simmons, L. Owen, 14, Altenburg-gardens, Clapham Junction, S.W.
June 20, 1895		Simons, A. J., c/o M. Simons, 31, Little Britain, E.C.
Feb. 20, 1896		Simpson, A. M., 4, Kitto-road, St. Catherine's-park, S.E.
1857	Trans.	Simpson, Maxwell, M.D., F.R.S., 9, Barton-street, West Kensington
May 29, 1886		Simpson, William Selby, 95, Darenth-road, Stamford Hill, N.
Dec. 7, 1893	Trans.	Sims, W. Edgar, Harfouley, Chemical Works, Manchester
May 16, 1889		Singer, Ignatius, The Poplars, Chapel-street, Calverley, Yorks.
Feb. 20, 1896		Sircar, Amrita Lal, 51, Sankaritola, Calcutta.
April 15, 1880		Skelton, J. R., The Homestead, Thorpe Village, Norwich
Feb. 2, 1883	Trans.	Skinner, Sidney, M.A., The Cavendish Laboratory, Cambridge
Feb. 18, 1892		Skurray, Thomas, United Breweries, Abingdon, Berkshire
April 17, 1879		Slater, Charles, 16, Northwick-terrace, St. John's Wood, N.W.
April 15, 1880	Trans.	Slater, Harold H., Laboratory and Cement Testing Office, Grays, Essex
Dec. 5, 1878		Slatter, George W., A.R.C.S., F.I.C., 12, Bromley-street, Stapley, Yorkshire
April 4, 1889		Slater, John W., 47, Clarisbrook-road, Walthamstow
May 16, 1895		Slocum, F. L., Linden-avenue Corner, Reynolds-street, Pittsburgh, Pa.
Feb. 5, 1863	Trans.	Smec, A. Hutchinson, The Grange, Hackledge, Carshalton, Surrey
Dec. 16, 1875		Smetham, Alfred, Analytical Laboratory, Cereal Chambers, 16, Brunswick-street, Liverpool
Dec. 5, 1872		Smith, A. Percy, 14, Endsleigh-gardens, N.W.
June 21, 1883		Smith, Adolphe, 4, Barclay-road, Walham Green
April 17, 1890	Trans.	Smith, Alexander, Ph.D., B.Sc., Univer. Chicago, Chicago, U.S.A.

Date of Election.

Feb. 16, 1889		Smith, Angus, 10, Ardgowan-street W., Greenock, N.B.
Dec. 15, 1881	Trans.	Smith, Bernard E., Alkali Acts Department, Local Government Board, Whitehall, S.W.; and 48, Percy-park, Tynemouth
Dec. 6, 1894	Trans.	Smith, Claude, Fernside, Haveringatte Bower, Romford, E.
Feb. 21, 1884		Smith, Edgar Francis, 35, Amptill-square, Hampstead-road, N.W.
Dec. 9, 1869		Smith, Edward, Heathfield House, Chudleigh, Devon
June 7, 1894	Trans.	Smith, Ernest A., 17, Oval-road, Regent's Park, N.W.
June 16, 1892		Smith, Ernest Heber,
Nov. 20, 1892		Smith, Fred., P.O. Box 1324, Johannesburg, S.A.R.
April 2, 1874		Smith, George, Nobel's Explosives Co., Polmont Station, Scotland
Dec. 20, 1883		Smith, George
Feb. 18, 1892		Smith, George P. Darnell, 80, Woodland-road, Bristol
Feb. 6, 1890		Smith, Harry Wood, B.Sc., Messrs. May and Baker, Garden Wharf, Church-road, Battersea
Mar. 16, 1878		Smith, H. R., 1, Aubert-park, Highbury, N.
May 5, 1892		Smith, John Meadows, Laboratory, 66, College-street, Chelsea, S.W.
Dec. 18, 1879		Smith, John William, Brookfield-street, Roslindale, Boston, Mass.
Dec. 5, 1895		Smith, Matthew, B.A., Aston Hall, Preston Brook, Cheshire
Feb. 19, 1891		Smith, R. Greig, Durham College of Science, Newcastle-on-Tyne
Feb. 16, 1888		Smith, Sam, 15, Springfield-road, Swindon
Nov. 18, 1883		Smith, Sidney, 35, Amptill-square, Hampstead-road, N.W.
April 7, 1856		Smith, Thomas J., F.G.S., Wilton-terrace, Hornsea, East Yorkshire
Feb. 3, 1876		Smith, W. A., M.A., M.B. Oxon, M.R.C.S. Eng., Newport, Essex
Dec. 20, 1866	Trans.	Smith, Watson, 34, Upper Park-road, Haverstock Hill, N.W.
Dec. 20, 1883	Trans.	Smithells, Arthur, Prof. B.Sc., The Yorkshire College, Leeds
Dec. 18, 1873		Smyth, John, M.A., Milltown, Banbridge, Ireland
Mar. 3, 1887	Trans.	Snape, Henry Lloyd, Prof., Chemical Laboratories, University College of Wales, Aberystwith
Feb. 3, 1887		Sohn, Charles, F.I.C., 50, Hop-exchange, S.E.
June, 18, 1891		Solomon, Frank Oakley, 103, Holly-avenue, Newcastle-on-Tyne
Dec. 17, 1874	Trans.	Sonstadt, Edward, Church Field, Cheshunt, Herts
Dec. 18, 1884	Trans.	Sorabji Bomanji, Khan Bahadur, Ph.D., C.E. (Bombay) Assoc., M.I.C.E. (Lond.), 8, Sleater-road, Bombay
June 15, 1893		Sorrell, Henry Thomas, Holly Lodge, Millbrook-road, Southampton
May 6, 1875		Southall, Alfred, Garrick House, Richmond Hill, Edgbaston
June 21, 1883		Soward, Alfred W., 23, Therapia-road, Honor Oak, S.E.
Dec. 15, 1892		Spackman, Charles, Rosehaugh, Clitheroe, Lancashire
Feb. 21, 1889		Speakman, James, Penhold, Post Office, Calgary, Alberta, Canada
Feb. 1, 1883		Spencer, Ernest Samuel, Arborfield, Wimbledon Park

Date of Election.

April 4, 1878		Spencer, James, B.Sc., 38, Ash-grove, Bradford
Mar. 4, 1886		Spencer, Richard, Woodside, Croslands Park, Barrow-in-Furness
Feb. 6, 1879		Spencer, Samuel, 21, St. George's-road and Castle Brewery, Castle-road, Southwark, S.E.
June 16, 1887		Spencer, W. Shelley, Lyndene, Darley, Farnworth, near Bolton
June 7, 1894		Spencer, John George, M.D., Ph.D., Prof., Western Reserve University, 370, Central-avenue, Cleveland, Ohio, U.S.A.
Feb. 3, 1859	Trans.	Spiller, John, 2, St. Mary's-road, Canonbury, N.
Jan. 15, 1863		Spiller, William, Atlas Dye Works, Hackney-wick, E.
June 18, 1885		Spilsbury, James, 15, Lichfield-road, Stafford
June 4, 1885		Spottiswoode, W. Hugh, Balliol College, Oxford; 41, Grosvenor-place, S.W.; and 6, Middle New-street, E.C.
Feb. 18, 1892		Spray, Henry John, c/o Messrs. Hopkins and Williams, Bridge-fields, Wandsworth, S.W.
Dec. 1, 1864	Trans.	Sprengel, Hermann Johann Philipp, Ph.D. (Heidelb.) F.R.S., Royal Prussian Professor (titular), Savile Club, 107, Piccadily, W.
Mar. 16, 1895		Squance, Thomas Coke, M.D., M.S., L.S.Sc., F.R.M.S., F.R. M. St. S., 4, Beauchere-terrace, Sunderland
May 4, 1882		Squire, P. Wyatt, 413, Oxford-street, W.
Feb. 4, 1858	Trans.	Squire, W. Stevens, Ph.D., Clarendon House, St. John's Wood-park, N.W.
Feb. 18, 1892		Squires, Alfred James, 84, Derby-road, Farnworth, Widnes, Lanes.
May 5, 1892		Stables, William Herbert, Rev., B.A.
June 21, 1877		Stacey, Henry George, 300, High Holborn, W.C.
Dec. 18, 1879	Trans.	Stallard, George, M.A., Horton Crescent, Rugby
April 21, 1859	Trans.	Stanford, Edward Charles, Glenwood, Dalmuir, Dumbartonshire
Mar. 17, 1887		Stanger, W. Harry, Chemical Laboratory, Broadway, Westminster
Feb. 3, 1887		Stansell, Lionell W., 4, Albion-place, Maidstone, Kent
May 16, 1895		Stansfield, A., B.Sc., Alder-ryde, Hainault-road, Leytonstone
Dec. 3, 1885		Staples, Henry J., Spondon, Derby
Dec. 15, 1870		Starey, Arthur J., 18, Ashley-road, Hornsey-rise, N.
Dec. 15, 1870	Trans.	Stark, J. Fleming, 21, Highfield-street, Rock Ferry, Birkenhead
Mar. 16, 1876		Starling, J. H., 32, Craven street, Strand, W.C.
Nov. 16, 1882	Trans.	Stead, J. E., Redcar, Middlesborough
May 4, 1882		Stebbins, James H., jun., Ph.D., 114, Pearl-street, New York
May 7, 1885		Steel, Robert Elliot, County School, Northampton
June 7, 1894		Steel, Robert W., Wedderburn, Paisley
Dec. 5, 1889		Steel, Sydney, 26, Somerset-street, Portman-square, W.
Dec. 4, 1890		Steel, Thomas, c/o Colonial Sugar Refining Co., Sydney, N.S.W.
Dec. 18, 1884		Steele, Robert, 8, Adelaide-square, Bedford
Jan. 17, 1884		Stenhouse, Thomas, 8, West-street, Rochdale
May 5, 1892	Trans.	Stenhouse, James, 38, Warrender Park-road, Edinburgh

Date of Election.

Dec. 5, 1895		Stephens, F. R., c/o Messrs. Idris, Pratt-street, Camden Town, N.W.
April 15, 1880		Stephens, Henry Charles, M.R. Inst., Avenue House, Finchley
Feb. 21, 1895		Stephenson, Herbert F., 10, Muschamp-road, E. Dulwich, S.E.
Dec. 3, 1885		Stephenson, Stephen, 93, Kensington, Liverpool
Dec. 3, 1891	Trans.	Stephenson, Thomas, Victoria House, Byculla, Bombay
Dec. 6, 1888	Trans.	Stern, Arthur Landauer, D.Sc., F.I.C., 170, Ashby-road, Burton-on-Trent
Dec. 15, 1881		Steuart, Daniel Rankin, Osborne Cottage, Broxburn, Linlithgowshire
Feb. 18, 1864		Stevenson, Thomas, M.D., Sandhurst Lodge, 45, Gresham-road, Brixton, S.W.
Feb. 6, 1879		Stevenson, William. 95A, Southwark-street, S.E.
June 20, 1872		Stewart, Walter, 1, Murrayfield-gardens, Edinburgh
Feb. 21, 1889		Stillman, Thomas B.
Dec. 15, 1881		Stitt, Charles Alfred, 29, Cluny-gardens, Edinburgh
June 21, 1866		Stock, W. F. K., 5, Dixon-terrace, Darlington
Feb. 19, 1891	Trans.	Stockdale, R., the Grammar School, Leeds
June 18, 1874		Stocks, Frederic, Snead's Green House, Droitwich, Worcestershire
Nov. 17, 1887		Stocks, Herbert B., 6, Manor-road, Churchtown, Southport
May 3, 1894		Stoddart, Frederick Wallis, Grafton Lodge, Sneyd Park, Bristol
April 17, 1879	Trans.	Stokes, A. W., Vestry Hall, Paddington
Dec. 18, 1873		Stone, Edward Daniel, Laboratory, 12, Lever-street, Piccadilly, Manchester
April 17, 1890		Stone, Frederick Richard M., 58, Upper Parliament-street, Liverpool
Dec. 5, 1895		Stone, George, Standard Brewery, Sydney, N.S.W.
Dec. 2, 1875		Stone, J. Harris, M.A., F.L.S., Barrister-at-Law, 4, Temple, E.C.
April 17, 1879		Stone, William, M.A. Cantab, F.L.S., Oxford and Cambridge, Garrick, and Union Clubs, and D. 6, The Albany, Piccadilly
May 7, 1891		Storey, James Ashburner, B.Sc., Elkaduwa, Ceylon
June 19, 1884		Stormouth, Thomas, Athol House, Clarence-road, St. Thomas, Exeter
Feb. 3, 1887		Strangman, J. Pim
May 7, 1885	Trans.	Stuart, Charles M., M.A., St. Dunstan's College, Catford, S.E.
Dec. 7, 1893		Styles, R. Curling, Knockhall, Greenhithe, Kent
Dec. 4, 1890	Trans.	Sudborough, J. Joseph, Ph.D., B.Sc., University College, Nottingham
Dec. 5, 1878	Trans.	Sugira, Shigetake, care of Tok'ō Chemical Society, Imagawa-koji 1, Tokio, Japan
Feb. 16, 1888		Sumner, Robert Mason, c/o Messrs. Parke, Davis and Co., Detroit, Michigan, U.S.A.

Date of Election.

Feb. 3, 1887		Sutherland, D.A., F.I.C., 23, Victoria-street, Westminster, S.W.
Feb. 21, 1884		Sutton, C. W., 19, Henley-road, Ipswich
April 19, 1860		Sutton, F., Laboratory, Bank Plain, Norwich
Mar. 4, 1886		Sutton, F. Napier, 6, Grosvenor-gardens, Willesden Green
June 3, 1875		Swan, Joseph Wilson, M.A., F.R.S., 58, Holland park, W
June 20, 1889		Swan, Robert, M. W., 15, Walmer-crescent, Glasgow
May 3, 1894		Swinburne, James, 66, Victoria-street, S.W.
Dec. 5, 1889		Sworn, Sidney Augustus, The New Municipal Technical School, Gravesend
Feb. 18, 1892		Sykes, James, 76, Lockwood-road, Huddersfield
Feb. 19, 1891		Sykes, M. Carrington, L.P.H. Lond., L.R.C.P. Lond., M.R.C.S. Eng., L.S.A. Lond., Sykeshurst, Barnsley, Yorks.
May 16, 1889		Sykes, Walter J., M.D., 59, Friend's-road, Croydon
Feb. 19, 1891		Symes, K. Edward, 12, Wilton-avenue, Southampton
June 17, 1880		Symons, Brenton, 11, Parade, Truro, Cornwall
Dec. 17, 1874		Symons, William Henry, M.D. (Brun.), D.P.H. (Oxon.), M.R.C.S. Eng., F.I.C., Junior Constitutional Club, Piccadilly, W.
Feb. 17, 1881	Trans.	Takamatsu, T., Engineering College, Imperial University, Tokio, Japan
Feb. 3, 1887	Trans.	Takamine, Jokichi, 6641, Woodlawn-avenue, Chicago, U.S.A.
Feb. 15, 1894		Tanner, Alf. E., Westminster Hospital, S.W.
Feb. 19, 1874		Tanner, Henry, Prof., The Wallauds, Silver Hill, St. Leonards
Dec. 4, 1890		Tate, Francis Henry, 9, Hackins Hey, Liverpool
Dec. 18, 1884		Tate, Walter, 43, Nerwood-grove, Liverpool
May 15, 1890		Tate, William, Ivy Cottage, Oakhill-road, Putney, S.W.
Dec. 5, 1867		Tatlock, Robert R., Novara, Stirling
Dec. 6, 1894		Taylor, Albert, Technical School, Stockport
Dec. 2, 1875		Taylor, Andrew, 11, Lutton-place, Edinburgh
Dec. 7, 1882		Taylor, G. Midgley, 27, Great George-street, Westminster
June 7, 1894		Taylor, Herbert J., 9, Portland-villas, Bath-street, Dewsbury
June 17, 1880		Taylor, James, B.Sc., Government Metallurgist, Department of Mines, Sydney, New South Wales
June 18, 1891		Taylor, John, 15, Lucius-street, Torquay
April 19, 1888		Taylor, John G., 16, Trinity-street, Stockton-on-Tees
Jan. 15, 1874	Trans.	Taylor, R. L., 37, Mayfield-road, Whalley Range, Manchester
Dec. 6, 1888		Taylor, William, China Sugar Refining Co., East Point, Hong Kong
April 4, 1878		Tcherniac, Joseph, Ph.D., Thalstrasse 1, Freiburg, Briesgau, Germany
April 17, 1879	Trans.	Teed, Frank L., D.Sc., 15, Victoria-street, S.W.
May 1, 1877		Terrill, William, 42, St. George's-terrace, Swansea
May 3, 1894		Terry, Edwin, 274, Brixton-road, S.W.
Feb. 15, 1881		Tervet, Robert, 54, Penshurst-road, South Hackney, E.

Date of Election.

June 18, 1891		Tetley, Frederick, 3, Mannville-terrace, Horton-road, Bradford
Feb. 16, 1893		Thackrah, James R., M.A., Ph.D., Technical Schools, Tavistock-road, Plymouth
May 16, 1895		Theodesius, A. F., B.A., University Coll., Oxford
Nov. 17, 1859		Thomas, Andrew, c/o M. C. Neville, Esq., 9, Hendley-street, Adelaide, South Australia
Dec. 7, 1871		Thomas, Charles, Woodcote, Stoke Bishop
Mar. 5, 1874		Thomas, Harry Edgecombe, Rockleaze Point, Clifton, Bristol
Feb. 18, 1875	Trans.	Thomas, Joseph William, Drumpellier, Brunswick-road, Gloucester
Feb. 5, 1863		Thompson, Beeby, 55, Victoria-road, Northampton
Mar. 4, 1886	Trans.	Thompson, Claude M., M.A., University College, Cardiff
June 7, 1894		Thompson, Edward Cumming, 48, Kestrel-avenue, Herne Hill, S.E.
June 15, 1893		Thompson, Frank Ernest, 97, Mardock-road, Handsworth, Birmingham
May 5, 1892		Thompson, George-de-Roos
May 4, 1893		Thompson, George R., The Laboratory, 57, Dock-street, Newport, Mon.
Dec. 16, 1886		Thompson, W. Phillips, 95, Shrewsbury-road, Cloughton, Birkenhead
Dec. 17, 1885	Trans.	Thomson, Andrew, D.Sc., 10, Pitcullen-terrace, Perth
Nov. 2, 1876		Thomson, George C., 23, Kersland-terrace, Hillhead, Glasgow
April 15, 1858	Trans.	Thomson, John, Gwydor Villa, Elmers End, Beckenham
Jan. 18, 1872	Trans.	Thomson, John Millar, King's College, W.C.; and 85, Addison-road, W.
Jan. 18, 1872		Thomson, William, Royal Institution Laboratory, Manchester
May 16, 1895		Thomson, W. T., Offord-villas, Walham Abbey
Dec. 3, 1885		Thorne, Edward E. H., care of H. E. Thorne, Esq., Bridgetown, Barbadoes, West Indies
Feb. 16, 1882	Trans.	Thorne, Leonard T., Ph.D., 8, Dynevor-road, Richmond
Nov. 20, 1890		Thornley, J., Brooks, jun., c/o Felton, Grimwash, and Co., Jeffcott street, Melbourne, Australia
May 16, 1895		Thornton, A., M.A., 67, St. Mary's-terrace, Manningham
Dec. 3, 1891		Thorp, Walter, B.Sc., Analytical Laboratory, Limerick
Feb. 1, 1866	Trans.	Thorp, William, B.Sc., 24, Crouch Hall-road, Crouch End, London, N.
Feb. 16, 1871	Trans.	† Thorpe, T. E., Ph.D. (Heid.), B.Sc. (Vict.), D.Sc. (Dubl.), LL.D. (Glas.), F.R.S., Inland Revenue, Somerset House, W.C.
Dec. 7, 1893	Trans.	Thorpe, Jocelyn Field, Ph.D., 20, Larkhall Rise, Clapham, S.W.
May 7, 1891		Thonger, C. G. Freer, M.R.A.C., Colonial College, Hollesley Bay, Suffolk
Dec. 2, 1875	Trans.	Thresh, J. C., D.Sc., Medical Officer of Health, Chelmsford
June 7, 1894		Thudichum, George Dupré, Montrose, Dorset-road, Merton Park, Wimbledon

† Longstaff Medallist, 1881.

Date of Election.

Dec. 20, 1880	Trans.	Thudichum, John L. W., M.D., 11, Pembroke-gardens, W.
Dec. 2, 1860		Thwaite, B. H., Moorfields-chambers, 95 and 97, Finsbury-pavement, E.C.
Dec. 5, 1895		Tibbals, W. J., 72, Lafayette-avenue, Detroit, Mich., U.S.A.
Feb. 19, 1863	Trans.	Tichborne, C. R. C., Ph.D., 15, North Great George-street, Dublin
Mar. 17, 1881	Trans.	Tiemann, Ferdinand, Prof., Dr., Parkstrasse, Wannsee, near Berlin
June 1, 1865	Trans.	Tilden, William A., Prof., F.R.S., 9, Ladbroke-gardens, W.
Dec. 5, 1889	Trans.	Tingle, J. Bishop, Ph.D., Gordon's College, Aberdeen
May 7, 1891		Tocher, James Fowler, A.I.C., 1, Chapel-street, Peterhead
June 2, 1864	Trans.	Tomlinson, Charles, F.R.S., 7, North-road, Highgate, N.
Feb. 21, 1884	Trans.	Tompson, Frederiek William, 1, St. Mildred's-road, Ramsgate
June 21, 1877		Toms, Frederick Woodland, F.I.C., 21, Grove-place, Jersey
Jan. 15, 1855	Trans.	Tookey, Charles, Museum of Practical Geology, Jermyn-street, S.W.
Dec. 3, 1868		Tosh, Edmund G., The Lund, Ulverston, Lancashire
Feb. 16, 1893		Towers, John William, Brantwood, Allerton, Liverpool!
Feb. 2, 1888		Townsend, Charles F., 31, Elms-road, Clapham Common, S.W.
June 6, 1887		Traphagen, Dr. Frank W., College of Agriculture, &c., Bozeman, Montana, U.S.A.
Feb. 18, 1892	Trans.	Travers, Morris W., 2, Phillimore-gardens, Kensington, W.
May 16, 1895		Trebarne, F. G., Wrangbrook, Llanishen, near Cardiff
Feb. 15, 1894		Trench, George, Cotton Powder Co., Faversham
Mar. 15, 1888		Trewby, Herbert, Radnor House, Ribblesdale-road, Hornsey, N.
June 16, 1881		Trigger, Oliver, Chemical Dept., Royal Arsenal, Woolwich
Dec. 5, 1889		Tucker, Willis G., M.D., Albany, New York, U.S.A.
May 5, 1892		Tuer, Arthur Holt, Thornhill, Wigan, Lancashire
Dec. 2, 1886		Turner, Arthur, L.D.S. Ed., The Limes, Aylesbury
Feb. 20, 1896		Turner, B. B., B.Sc., 28, Lady Somerset-road, N.W.
Dec. 6, 1888		Turner, Charles, 225A, Oxford-street, Manchester
Feb. 1, 1883	Trans.	Turner, Thomas, Roseneath, Rowley Park, Stafford
Feb. 21, 1889	Trans.	Turpin, George Sherbrooke, M.A. (Cantab), D.Sc. (Lond.), Schoolhouse, Swansca
Dec. 15, 1892		Turton, Albert Henry, F.R.G.S.
Feb. 2, 1871		Tustin, John Robt., North End House, The Marina, Deal
Feb. 2, 1888	Trans.	Tutton, Alfred E., 6, Manor-road, Holywell, Oxford
June 19, 1879		Tweedie, George R., 8, Victoria-parade, East Cliff, Ramsgate
May 5, 1892		Tweedie, Thomas Shortridge, The Moat, Annan
Feb. 17, 1876		Typke, P. G. W., Ravenhurst, New Malden
Dec. 7, 1876		Tyrer, Thomas, Stirling Chemical Works, Abbey-lane, Stratford
Dec. 3, 1885		Tyson, Thomas B., 1, New China Bazaar-street, Calcutta
April 6, 1876		Udall, Thomas Bertram, Newcastle-under-Lyme, Staffordshire
Nov. 16, 1865		Umney, Charles, 50, Southwark-street, S.E.

Date of Election.		
Feb. 16, 1893	Trans.	Umney, John C., 50, Southwark-street, London, S.E.
Feb. 21, 1889		Underhill, Thomas J., 6, The Terrace, Royal Victoria Yard, Deptford, S.E.
Mar. 16, 1882		Vacher, Francis, 7, Shrewsbury-road, Oston, Birkenhead
Mar. 6, 1890		Valentin, Basil William, Messrs. Buckley Bros., Brewery, Llanelly, S. Wales
Dec. 1, 1887		Vargas, Vergara J. M., 237 P.O. Box, Bogota, Columbia, S. America
Mar. 1, 1883		Vasey, S. A., Kingsthorpe, Lower Park, Loughton, Essex
Dec. 7, 1882		Vasey, Thomas E., 6, South-parade, Leeds, and P.O., Box 1149, Montreal, Canada
June 15, 1893		Vantin, Claude T. J., 42, Old Broad-street, E.C., and 3, Upper Hamilton-terrace, N.W.
Dec. 6, 1894		Vaux, Cuthbert, 11, Thornhill-park, Sunderland
April 17, 1879	Trans.	Veley, Victor H., M.A., F.R.S., 22, Norham road, and University Museum, Oxford
Feb. 19, 1891		Velling, F. W. De, B.A., Higher Grade Board School, The Boulevard, Hull
May 6, 1881		Venable, Frank P., Ph.D., Chapel Hill, North Carolina
Jan. 18, 1872		Vincent, Charles W., F.R.S.E., F.C.S. of Berlin, Reform Club, Pall Mall, S.W., and Royal Institution, W.
May 16, 1889		Virtue, William, Abbey-street and Waterside Distilleries and Mills, Londonderry
Feb. 21, 1884		Voelcker, Edward William, 22, Tudor-street, Blackfriars, E.C.
Jan. 17, 1884		Voelcker, John A., Ph.D., 20, Upper Phillimore gardens, Kensington, W.
April 4, 1889		Voss, Walter Arthur, 159, Croydon-road, Anerley, S.E.
Nov. 19, 1885		Vnlte, Hermann T., Ph.B., School of Mines, Columbia College, East 42th-street, corner of 4th-avenue, New York
Feb. 6, 1890		Wade, John, B.Sc. (Lond.), Wyvenhoe, Purley, and Gny's Hospital, S.E.
Dec. 6, 1894		Wagner, W. G., Glyndhurst, Ealing Common, W.
April 17, 1884		Wainwright, J. Howard, Ph.D., 22, West 46th Street, New York, City, U.S.A.
Feb. 16, 1893		Wait, Chas. E., Prof., University of Tennessee, Knoxville, U.S., N.A.
May 17, 1888		Wait, Frank Goodell, Geological Survey Department, Ottawa
Dec. 7, 1893		Walden, William Herbert, 57, Felix-road, Brixton, S.W.
Feb. 15, 1866	Trans.	Walenn, W. H., 9, Carleton-road, Tufnell Park, N.
Feb. 16, 1893		Walke, Willoughby, 1st Lieut., Fort Monroe, Virginia, U.S., N.A.

Date of Election.

Jan. 16, 1868		Walker, Maj.-Gen. Alexander, C.S.I., R.A., Director-General of Ordnance, Race View, Simla, India
Mar. 17, 1881		Walker, Archibald, B.A., 8, Crown-terrace, Dowanhill, Glasgow
June 7, 1894	Trans.	Walker, Chas. H. H., B.A., 28, College Grove-road, Wakefield
Dec. 5, 1889		Walker, Daniel, A.K.C., B.Sc.
Feb. 6, 1890	Trans.	Walker, James, Prof., D.Sc., 8, Windsor-terrace, Dundee
Feb. 2, 1865	Trans.	Walker, J. F., M.A., 45, Bootham, York; and Sidney College, Cambridge
April 17, 1890		Walker, James S. H., M.B., C.M., 11, Leopold-street, Nairn
Dec. 6, 1888		Walker, J. T. Ainslie, McMurray's Royal Paper Mills, Wandsworth
Feb. 17, 1881		Walker, Robert William, Bank Cottage, Edgworth, near Bolton
April 17, 1879		Walker, Thomas Hatfield, 1, Pieton-place, Newcastle-on-Tyne
June 4, 1884		Wallace, Prof. Robert, The University, Edinburgh
Dec. 5, 1878		Waller, Elwyn, Ph.D., 440, 1st-avenue, New York
Mar. 3, 1887		Wallis, Henry Weston, 11, Probyn-road, Tulse Hill, S.W.
Mar. 1, 1883		Walmsley, R. Mullineux, D.Sc., Northampton Institute, St. John Street-road, Clerkenwell, E.C.
Dec. 6, 1888		Walrood, Edward Dalrymple, B.A., North Eastern Counties School, Barnard Castle, Durham
Mar. 20, 1884		Walton, Thomas Ulrick, B.Sc., F.I.C., Colonial Sugar Refinery Co., Sydney, New South Wales
April 21, 1864		Ward, George, Buckingham-terrace, Headingley, Leeds
May 16, 1895		Ward, G. T., Hallam Fields, Ilkeston
Dec. 3, 1891		Ward, Thomas Armistead,
April 20, 1871		Ward, William, Sheffield Moor, Sheffield
Dec. 4, 1873		Warden, C. J. H., Prof. of Chemistry, Medical College, Calcutta
May 20, 1875		Wardle, Thomas, F.G.S., Leek, Staffordshire
Mar. 19, 1863	Trans.	Warrington, Robert, F.R.S., High Bank, Harpenden, St. Albans
Feb. 21, 1895		Warrington, T. C., 52, Regents-road, Hanley, Staffs.
June 15, 1893		Warmington, Edward A., Ph.D., F.I.C., 36, Cannon-st., Birmingham
Dec. 7, 1871		Warner, George Joseph, 41, Albert-road, Widnes
May 5, 1891		Warren, Cyprian A., Messrs. Watney's Brewery, Richmond
Dec. 6, 1894		Warren, W. L., 12, Westland-row, Dublin
Dec. 6, 1888		Warrick, Frederic Walmsley, 59, Great Ormond-street, W.C.
Nov. 17, 1887	Trans.	Warrington, Arthur Walley, University Coll. of Wales, Aberystwith
May 16, 1895		Warwick, A. W., Minth Mines, Wickes, Mont., U.S.A.
Nov. 16, 1882		Waterfall, Charles J., Marienberg, Somerville-road, Bristol
June 7, 1894		Waterfield, A. Swainson, Grammar School, Bromyard, Worcester
Dec. 6, 1894		Waterhouse, Robert, 101, Leadenhall-street, E.C.
April 4, 1889		Waterhouse, Wm. John, B.Sc., Christ Church, Oxford
Mar. 15, 1888		Watts, Edward Arthur, Coromandel Gold Mg. Co., Oorgaum, Mysore
May 4, 1893		Watson, A. Forbes, Chemistry Dept., University of Edinburgh
Mar. 5, 1885		Watson, Charles, Walsden Chemical Works, near Todmorden

Date of Election.

Jan. 18, 1872		Watson, David, D.Sc., The Broughton Copper Works, Salford, Manchester, and Willow Bank House, Kersal Dale, Higher Broughton
June 16, 1887		Watson, Frederick Percy, 6 and 7, Bailgate, Lincoln
May 4, 1882		Watson, George, 16, East Nelson-street, Whitevale, Glasgow
Mar. 1, 1883		Watson, Thomas Donald, 16, St. Mary's-road, Bayswater, W.
Jan. 20, 1876	Trans.	Watson, W. H.
June 21, 1877		Watt, Alexander, c/o Messrs. Macfie and Sons, 34, Moorfields Liverpool
Mar. 1, 1883	Trans.	Watts, Francis, Govt. Laboratory, St. John's, Antigua, W. Indies
Feb. 1, 1872	Trans.	Watts, John, D.Sc., Merton College, Oxford
Dec. 5, 1878	Trans.	Watts, John I., Fairleigh, Hartford, Cheshire
Dec. 6, 1888		Way, Edward J., F.I.C., Eastleigh Syndicate, Box 84, Keerksdorp, Transvaal, S.A.R.
June 6, 1872		Weaver, Richard, C.E., The Sanitary Laboratory, Manor-street, Clapham, S.W.
Mar. 1, 1883	Trans.	Webster, Charles Stuart, Maivern House, Redland, Bristol
Mar. 1, 1866		Webster, G. W., 33, Bridge-street-row, Chester
June 21, 1877		Webster, William, Glencot, Blackheath Park, Blackheath, S.E.
April 4, 1889		Weir, P. A., Surgeon-Major, M.B., Agency Surgeon, Beloochistan, <i>via</i> Quetta
Feb. 16, 1888		Welch, J. Cutlibert, Messrs. Simonds, The Brewery, Reading
Dec. 7, 1893		Welchman, Frank Ernest, 16, Carlton-road, Putney Hill, S.W.
Feb. 19, 1891		Wellington, Stephen N., M.I.C.E., The Bungalow, The Gas Works, Parel, Bombay
June 19, 1884	Trans.	Wells, James S. C., Ph.D., Hackensack, New Jersey, U.S.A.
Feb. 6, 1890		Wells, S. Russell, B.Sc., M.B., 29, Devonshire-street, Portland-place, W.
Feb. 18, 1888	Trans.	Werner, Emil A., 5, Church-avenue, Rathmines, Dublin
Dec. 15, 1892		Westaway, Frederick William, B.A., Fair View, South Woodford
Dec. 6, 1883		Wetzel, Henry A., Messrs. Parke, Davies & Co., Box 470, Detroit, Michigan, U.S.A.
Mar. 4, 1886		Wertheimer, Julius, Prof., B.Sc., B.A., F.I.C., Merchant Venturers' Technical College, Bristol
May 5, 1892		Whalley, Lawrence J. de Lancaster, 26, Park-place, Greenwich, S.E.
June 15, 1893		Whalley, Sydney, 38, Havelock-street, Canterbury
May 3, 1894		Wheeler, H. L., Ph.D., 1812, Prairie-avenue, Chicago
Feb. 16, 1893		Wheeler, William Ernest, 18, Bessborough-gardens, Pimlico, S.W.
May 16, 1895		Whiston, W. A., Blurton-road, Fenton, Staffs
April 17, 1879		Whitaker, Thorp, Messrs. Ripley & Sons', Dye Works, Bradford, Yorkshire
Feb. 16, 1893		White, H. C., Prof., Athens, Georgia, U.S.A.

Date of Election.

Dec. 3, 1891		White, Henry, 43, Woodstock-road, Sheffield
Mar. 20, 1862		White, Leedham, 2, Lime-street-square, E.C.
April 4, 1889		White, John Tsawoo, M.A., F.I.C., Treasury Office, Katha, Upper Burmah
Dec. 7, 1893		White, William Gilchrist, Broadbottom P. O., near Manchester
Feb. 5, 1835		Whitehead, Henry H., The Royal Brewery, Brentford
Dec. 5, 1889		Whitehouse, William, Albany House, Bradmore, Wolverhampton
Dec. 15, 1892		Whiteside, John Lowe, 51, Cannon-street, Bolton
June 16, 1892		Whiteley, Fred., B.A., Broome House, Shrewsbury
April 15, 1886	Proc.	Whiteley, R. Lloyd, 20, Beeches-road, W. Bromwich
Nov. 5, 1863		Whitfield, John, 113, Westborough, Scarborough
June 15, 1893		Whittaker, Thomas, 76, Arden-terrace, Accrington
Dec. 5, 1889		Whittam, Matthew, M.A., The Isle of Wight College, Ryde
Dec. 5, 1889		Wigan, Basil P., Rhondda Valley Brewery Co., Treherbert
May 16, 1895		Wigley, H. F. A., 1, Eton-grove, Dacre Park, S.E.
Dec. 15, 1892		Wigham, F. H., Cherrygarth, Eastmoor-road, Wakefield
May 7, 1891		Wild, John, 23, Hyde-road, Woodley, Stockport
June 16, 1881		Wilkes, J. P., 54½, Old Broad-street, E.C.
Feb. 19, 1891		Wilkinson, David, 244, St. Paul's road, Preston
May 4, 1893		Wilkinson, John, Drighlington, near Bradford
Dec. 17, 1835		Will, Wm. Watson, 1, St. Agnes-place, Kennington Park, S.E.
Feb. 19, 1891		Will, W., Ph.D., Beethoven-strasse, No. 1, Berlin, N.W.
Jan. 16, 1862	Trans.	Williams, C. Greville, F.R.S., F.I.C., Castlemaine, Oakhill road, Putney, S.W.
Feb. 21, 1895		Williams, Evan, Gas Works, Manchester
Dec. 15, 1892		Williams, John, Government Laboratory, British Guiana
Dec. 5, 1895		Williams, J., B.A., Wesley Coll., Sheffield
June 21, 1883	Proc.	Williams, Rowland, Sunny Lea, Aldcliffe-road, Lancaster
June 18, 1891		Williams, Seward W., c/o Scabury and Johnson, 8, Brighton- avenue, East Orange, New Jersey, U.S.A.
Dec. 5, 1872		Williams, Thomas, Chemical Laboratory and Assay Office, A, Queen Insurance-building, 10, Dale-street, Liverpool
Mar. 5, 1885	Trans.	Williams, Walter Collingwood, B.Sc., 68, Grove-street, Liverpool
Feb. 19, 1874	Trans.	Williams, W. Carleton, 25, Broomgrove-road, Sheffield
Dec. 15, 1892		Williams, William, County Offices, Westgate-street, Cardiff, and 63, Plymouth-road, Penarth
Feb. 7, 1878		Williams, W. J., 635, Market-street, Camden, N.J., U.S.A.
Feb. 15, 1894		Williams, W. Lloyd, 10, Miskin-road, Dartford, Kent
May 15, 1848	Trans.	Williamson, A. W., LL.D., F.R.S., High Pitfield, Haslemere
Dec. 4, 1874	Trans.	Williamson, Robert, Low Walker, Newcastle-on-Tyne
Mar. 4, 1886	Trans.	Williamson, Sidney, Cent. Tech. Coll., S. Kensington
June 15, 1871		Willmore, Charles, Queenwood College, near Stockbridge, Hants
Dec. 5, 1872		Wills, Jos. Lainson, c/o Dr. Wyatt 12, Old Slip, New York
Dec. 5, 1892		Wilsmore, N. Y. M., 31, Stanley-gardens, Hampstead. N.W.

Date of Election.

Feb. 5, 1835		Wilson, A. C., Borough Hall, Stockton-on-Tees
June 19, 1879		Wilson, Charles J., 14, Old Queen-street, Westminster
Dec. 6, 1894		Wilson, Christopher, The Grammar School, Manchester
June 21, 1883	Trans.	Wilson, David, jun., Carbeth, Killearn, by Glasgow
Nov. 19, 1855		Wilson, G. F., F.R.S., Heatherbank, Weybridge Heath
Feb. 21, 1895		Wilson, H., 146, High-street, Southampton
April 1, 1875		Wilson, James, M.A., Barrister-at-law, 2, Essex-court, Temple and 15, Highbury-grange, Highbury, N.
May 16, 1878		Wilson, James Henry, 6, Fenchurch-buildings, E.C.
May 16, 1895		Wilson, John, B.Sc., Battersea Polytechnic, S.W.
Dec. 3, 1891		Wilson, John Henry, A.I.C., 29, Radford-street, Coventry
Nov. 20, 1890		Wilson, J. Mitchell, M.D., Medical Officer of Health, Doncaster
Dec. 6, 1894		Wilson, R. H., Washing Stocks Farm, Bromsgrove
Dec. 7, 1871		Wilson, William John, 6, Malden-road, Watford
Dec. 17, 1885		Wilson, William M., 63, Queen's square, Bristol
Feb. 5, 1874		Wiltshire, Thomas Pemberton, c/o New York Tartar Com- pany, 9th-street and Gowanus Canal, Brooklyn, New York
Dec. 18, 1884		Wilton, Thomas, The Gas Light and Coke Co., Beckton, North Woelwich
Dec. 1, 1887		Winder, Bartlett W., Sunny Bank House, 43, Broomhall-place, Sheffield
Dec. 7, 1893		Winder, Edward Humphreys, Westminster School, S.W.
Feb. 15, 1894		Wingate, Hamilton M., B.Sc., Bishopscourt, Ballarat
Dec. 5, 1895		Wingfield, T. R., Nelson-square, Bolton
Mar. 16, 1876		Winser, Percy James, Greendale, Bebington, near Birkenhead
Mar. 2, 1857		Winstone, Benjamin, M.D., 100, Shoe-lane, E.C., and 53, Russell- square, W.C.
Dec. 3, 1891		Winterton, A. W., 6, Linden-terrace, Rotherham
June 15, 1876	Trans.	Witt, Otto N., Ph.D., 33, Lindenallee, Wes end, Charlottenburg, near Berlin
Dec. 5, 1867		Wood, Augustus A., 74, Cheapside, E.C.
April 4, 1889		Wood, Charles, 21, Queen's-road, Bradford, Yorks
Jan. 19, 1860	Trans.	Wood, Charles Henry, Bellevue, Rusham-road, Egham
Dec. 4, 1890		Wood, Sidney, B.Sc., S. Kensington Museum, S.W.
Dec. 18, 1884		Wood, William H., B.A. (Oxon.), La Martinière, Calcutta
Feb. 19, 1880		Wood, W. H., 3, New-road, Halifax
Dec. 7, 1871	Trans.	Woodcock, Reginald C., The American and Continental Sanita- tion Company, 626 to 642, West 55th-street, New York
Feb. 18, 1892		Woods, Hugh, 11, Archway-road, Highgate, N.
April 19, 1888		Woodward, James, B.Sc., B.A., F.I.C., 144, Osborne-road, Forest Gate, E.
April 4, 1889		Woolf, Mortimer, 16, Greville-place, N.W.
Dec. 6, 1889		Woosnam, Richard W., 43, Dean-road, Willesden Park, N.W.
Nov. 19, 1885		Wormley, Theodore G., M.D., University of Pennsylvania, De- partment of Medicine, Philadelphia

Date of Election.

Dec. 18, 1884		Worrall, J. Hall, F.I.C., Howsley, Chapeltown, near Sheffield
Feb. 4, 1858	Trans.	Worsley, Philip J., Rodney Lodge, Clifton, Bristol
Dec. 5, 1895		Wright, H. E., Springhurst, Hartburn, Stockton-on-Tees
Feb. 21, 1878	Trans.	Wright, Lewis Thompson, 1, Victoria-street, Westminster, S.W.
June 7, 1894		Wright, Robert, 11, Eagle-parade, Buxton
Mar. 4, 1886	Trans.	Wright, William T., 8, Grange-crescent, Sheffield
Feb. 4, 1864		Wrightson, John, Charford House, Salisbury
Feb. 19, 1891		Wyatt, Thomas M., Chemical Department, Royal Arsenal, Woolwich, S.E.
Dec. 2, 1880		Wyborn, John Middleton, 26, Widmore-road, Bromley, Kent
Nov. 20, 1884		Wyley, W. Fitzthomas, Wheatly-street, Coventry
May 7, 1885	Trans.	Wynne, W. P., D.Sc., Royal College of Science, South Kensington, and 35, Parson's-green, Fulham, S.W.
June 4, 1874		Yates, Robert, 64, Park-street, Southwark
Dec. 16, 1886	Trans.	Yoshida, H., Science College, Imperial University, Tokyo, Japan
Feb. 5, 1895		Young, Alfred C., 64, Tyrwhitt road, St. John's, S.E.
Mar. 4, 1886		Young, Brougham, Riverside Works, Hackney Wick
Mar. 15, 1877		Young, Frank W., High School, Dundee, and Woodmuir, West Newport, Fife, N.B.
Dec. 4, 1890	Trans.	Young, George, Ph.D., Firth College, Sheffield
Feb. 21, 1895		Young, H. Stow, 13, Balham-grove, S.W.
June 21, 1877		Young, J. Rymer, 42, Sankey-street, Warrington
Feb. 5, 1874		Young, John, 164, Bath-street, Glasgow
June 16, 1887	Trans.	Young, John William, B.Sc., B.A., Analyst's Office, Great Northern Railway Plant, Doncaster, and 25, Hall Gate, Doncaster
Feb. 16, 1882	Trans.	Young, Sydney, D.Sc., F.R.S., University College, Bristol, and 10, Windsor-terrace, Clifton, Bristol
Dec. 16, 1894		Young, James, 4, Plumstead Common-road, Woolwich
Nov. 6, 1873		Young, W. C., Normanhurst, High-road, Romford, and Chemical Laboratory, Aldgate House, E.C.
April 4, 1878		Zingler, Maximilian, 19, Buckland-crescent, Belsize Park, N.W., and 16, Fenchurch-street, E.C.

FOREIGN MEMBERS.

NUMBER NOT TO EXCEED FORTY.

Date of Election.

May 18, 1876	Baeyer, Adolph von, F.R.S., University of Munich
Feb. 1, 1883	Beilstein, Prof. F., Ph.D., Technological Institute, St. Petersburg
Mar. 1 1860	Berthelot, M., F.R.S., Collège de France, Paris
Feb. 2, 1888	Boisbaudran, Lecoq de, 36, Rue Prony, Paris
Feb. 1, 1842	Bunsen, R. W., Ph.D., F.R.S., University of Heidelberg
June 19, 1862	*Cannizzaro, S., Senato di Roma
Feb. 1, 1883	Cleve, Prof. P. T., Ph.D., University, Upsala, Sweden
Feb. 1, 1883	Erlenmeyer, Prof. E., Ph.D., Frankfurt-on-Main
June 16, 1892	Fischer, Emil, Ph.D., University of Berlin
Feb. 1, 1883	Fittig, Prof. R., Ph.D., University, Strassburg
Nov. 4, 1844	Fresenius, C. Remigius, Ph.D., Wiesbaden
May 18, 1876	Friedel, C., École des Mines, Paris
May 3, 1866	Gibbs, Prof. Wolcott, Cambridge, Massachusetts, U.S.
June 16, 1892	Graebe, Carl, Ph.D., University of Geneva
Feb. 2, 1888	Hoff, Prof. J. H. van't, Ph.D., 103, Stadtonderskade, Amsterdam
June 19, 1862	Kekulé, Prof. A., F.R.S., University of Bonn
Feb. 2, 1888	Ladenburg, Prof. A., Ph.D., Kaiser Wilhelmstrasse, 43, Breslau
Feb. 2, 1888	Landolt, Prof. H., Ph.D., Königgratzerstrasse, 123B, Berlin, W.
June 16, 1892	Lieben, Adolph, Ph.D., University of Vienna
Feb. 1, 1883	†Mendeléef, Prof. D., Ph.D., University, St. Petersburg

* Faraday Lecturer, 1872.

† Faraday Lecturer, 1889.

Date of Election.	
Feb. 1, 1883	Meyer, Prof. Victor, Ph.D., University of Heidelberg
Feb. 2, 1888	Nilson, Prof. L. F., Ph.D., Albano, Stockholm
Mar. 1, 1860	Peligot, E., à la Monnaie, Paris
May 3, 1866	Rammelsberg, Prof. C. F., Berlin
June 16, 1892	Schiff, Hugo, Ph.D., University of Florence
June 16, 1892	Schlœsing, Th., Ph.D., Institut Agronomique, Paris
May 18, 1876	Thomsen, Prof. Julius, Ph.D., University of Copenhagen
Feb. 2, 1888	Wislicenus, Prof. Johannes, Ph.D., University, Leipzig

 FARADAY LECTURERS.

1869. J. B. A. Dumas.
 1872. S. Cannizzaro.
 1875. A. W. von Hofmann.
 1879. A. Wurtz.
 1881. H. von Helmholtz.
 1889. D. Mendeléef.
 1895. Lord Rayleigh.
-

LONGSTAFF MEDALLISTS

1881. T. E. Thorpe, F.R.S.
 1884. C. O'Sullivan, F.R.S.
 1888. W. H. Perkin, F.R.S.
 1891. F. R. Japp, F.R.S.
 1894. H. T. Brown, F.R.S.

PROCEEDINGS
OF
THE CHEMICAL SOCIETY.

Vol. XIII. Nos. 173—186.
JANUARY—DECEMBER, 1897.

EDITED BY THE SECRETARIES.

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1898.

RICHARD CLAY AND SONS, LIMITED,
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DATES OF ISSUE OF THE MONTHLY NUMBERS OF THE
JOURNAL OF THE CHEMICAL SOCIETY TO FELLOWS.

January number was issued.....	22nd February.
February „	23rd March.
March „	8th April.
April „	27th April.
May „	13th May.
June „	9th June.
July „	19th July.
August „	5th August.
September „	1st September.
October „	12th October.
November „	5th November.
December „	7th December.

LIST OF GRANTS MADE FROM THE RESEARCH FUND DURING THE YEAR.

£10 to Dr. J. J. Sudborough for the continuance of his researches on substituted cinnamic acids, and the stilbene series.

£10 to Dr. G. Young for the continuance of his researches on isomerism in the triazole series.

£25 to Mr. H. B. Baker for apparatus and materials for a research on tellurium.

£20 to Drs. J. J. Dobbie and Marsden for the purchase of corydoline for further investigations.

£10 to Dr. F. D. Chattaway for materials for the synthesis of ortho-diphenylbenzene, and for a research on the action of sodium on the three dichlorobenzenes.

£10 to Prof. A. E. Dixon, M.D., for materials for an investigation of the action of thiocyanates on acid chlorides.

£10 to Dr. J. Walker for the preparation of normal acids of the succinic series.

£20 to Dr. J. J. Sudborough for the continuation of researches on diortho-substituted benzoic acids, unsaturated compounds, esters, &c.

£15 to Mr. W. J. Sell for a research on the chlorination of pyridine.

£10 to Mr. H. A. Auden for the preparation of a closed chain pentacarbon derivative from the ethylic ester of an acetoisocönanthic acid.

£10 to Dr. F. E. Garrett for materials for an investigation of the pyridine bases of coal tar.

LIST OF FELLOWS ELECTED DURING 1897.

Name.	Proposed.	Elected.
Ackroyd, William.....	May 6th.	June 17th.
Alexander, John Owen.....	February 4th.	March 4th.
Aquino, Thomas Hannibal.....	January 21st.....	" "
Arbuckle, William.....	" "	" "
Ashworth, John B.	February 4th	" "
Ball, John, Ph.D.....	June 3rd	December 2nd.
Ball, William.....	November 4th	" "
Barclay, John, B.Sc.	February 4th	March 4th.
Barlow, Herbert W. L., M.A., M.B.....	February 18th	May 6th.
Barlow, William.....	April 1st	" "
Barlow, Walter Harry	May 20th	June 17th.
Bastow, Frank.....	February 4th	March 4th.
Beadle, Alec. Alfred.....	June 3rd	December 2nd.
Bhaduri, Jyoti Bhushan, M.A.	December 17th, 1896.	March 4th.
Boylan, Alfred Hunter	March 18th	May 6th.
Brierley, James	April 1st	" "
Brothers, William Malam.....	May 6th	June 17th.
Brown, F. Hewlett Burton, M.A.....	February 18th	March 4th.
Brown, Gerald Noël.....	April 29th.....	June 17th.
Brown, James Herbert.....	December 3rd, 1896..	March 4th.
Burland, Richard Oxley, J.P.....	November 4th	December 2nd.
Cameron, Alexander McLean	" "	" "
Cameron, Ernest Stuart	May 20th	June 17th.
Cartmell, Alfred.....	December 17th, 1896.	March 4th.
Chikashigé, Masumi, B.Sc.....	January 21st.....	" "
Cholerton, Alfred Foster	" "	" "
Clarkson, Alexander.....	November 4th	December 2nd.
Clutterbuck, Medwin C., B.Sc., Ph.D....	May 20th	June 17th.
Collingridge, Frank, B.Sc.	November 4th	December 2nd.
Cranfield, William	May 6th.....	June 17th.
Creasey, Clarence Hamilton	January 21st.....	March 4th.
Crofts, James Murray, B.A.	November 4th	December 2nd.
Crowther, James, B.Sc.	January 21st.....	March 4th.
Daniell, John.....	November 4th	December 2nd.
Davidge, Henry Norris.....	March 18th	May 6th.
Davis, William Alfred.....	January 21st	March 4th.
Deverell, Louis Charles.....	February 18th	May 6th.
Diamond, William.....	December 17th, 1896.	March 4th.
Dixon, Andrew James	November 4th.....	December 2nd.
Dodgson, John Wallis, B.Sc.	December 3rd, 1896..	March 4th.
Duckham, Alexander.....	April 1st ...	May 6th.
Duffy, Lawrence	December 3rd, 1896..	March 4th.
Edwards, William Buckland.....	December 17th, 1896.	" "
Fenby, Alaric Vincent C., B.Sc.	March 4th.....	May 6th.
Field, Charles Henry.....	" 18th.....	" "
Gibbons, Joseph Lake.....	December 3rd, 1896 ..	March 4th.
Gilbody, Alexander W., M.Sc., Ph.D....	" "	" "

Name.	Proposed.	Elected.
Girtin, Thomas, B.A.	March 18th	May 6th.
Gomess, A. Bilderbeck	May 6th	June 17th.
Gough, Harold Walter, B.A.	December 3rd, 1896..	March 4th.
Goulding, Ernest	January 21st	" "
Grundey, Frederick Roscoe, B.Sc.	May 6th	June 17th.
Guest, Edward Graham, M.A.	February 4th	March 4th.
Guttman, Oscar	June 17th	December 2nd.
Guyer, R. Glode	March 4th	May 6th.
Halliwell, Edward	May 6th	June 17th.
Hamilton, Robert	November 4th	December 2nd.
Harbord, Frank William	May 20th	June 17th.
Harger, John, B.Sc., P.D.	November 4th	December 2nd.
Harley, Vaughan, M.D.	December 17th, 1896.	March 4th.
Harman, Harold	May 6th	June 17th.
Harrie, Harold William	April 1st	May 6th.
Harrington, B. J., Ph.D.	May 20th	June 17th.
Hartley, Ernald G. Justinian, B.A.	December 3rd, 1896..	March 4th.
Hartley, Thomas	February 4th	" "
Heppenstall, Charles	January 21st	" "
Hill, Sydney	April 1st	May 6th.
Holmes, John	February 4th	March 4th.
Horseman, James Walter	June 3rd	December 2nd.
Ibbotson, Fred, B.Sc.	December 17th, 1896.	March 4th.
Innes, William Rose, B.Sc., Ph.D.	November 19th, 1896	" "
Jerdan, David Smiles, M.A., B.Sc.	December 17th, 1896.	" "
Johnson, Harold	January 21st	" "
Johnson, Otis C.	February 4th	" "
Kelly, Charles	November 4th	December 2nd.
King, Herbert	February 4th	March 4th.
Lang, William Robert, B.Sc.	January 21st	" "
Lasseter, W. J. G., M.A.	February 18th	May 6th.
Lee, Theophilus Henry	November 19th, 1896	March 4th.
Lemmey, Tom, B.A.	November 4th	December 2nd.
MacCulloch, Charles	March 18th	May 6th.
Mackenzie, John Edwin, B.Sc., Ph.D.	May 20th	June 17th.
Maclaurin, James Scott, D.Sc.	November 4th	December 2nd.
Macmullan, Alan, B.A.	" "	" "
Mallinson, Willie Lee	April 1st	May 6th.
Mansford, Charles Jodrell, B.A.	June 3rd	December 2nd.
Martin, Charles Henry	December 3rd, 1896..	March 4th.
Masters, Edward	November 4th	December 2nd.
Matthews, John A., M.A., M.Sc.	" "	" "
Merson, George Fowlie	March 18th	May 6th.
Miller, Edmund Howd, M.A., Ph.D.	April 1st	" "
Mitchell, Tom	March 4th	" "
Moon, Philip George Gregory	November 4th	December 2nd.
Morgan, Frederick Filmer de	February 18th	May 6th.
North, Barker	January 21st	March 4th.
Orton, Joseph Previte K., B.A., Ph.D.	April 1st	May 6th.

Name.	Proposed.	Elected.
Parker, Charles Henry.....	February 4th	March 4th.
Philip, James Charles, B.Sc., Ph.D.....	November 4th	December 2nd.
Phillips, Harry E.W., B.A.	February 18th	May 6th.
Pickard, Robert Howson, B.Sc.....	March 4th	" "
Pollitt, Samuel, B.Sc.....	February 4th	March 4th.
Pollock, William Robertson.....	May 6th	June 17th.
Pullar, Herbert Spindler.....	January 21st	March 4th.
Ralston, William, B.Sc.	" "	" "
Reid, Alexander Ferguson	November 4th	December 2nd.
Remington, John Stewart	January 21st	March 4th.
Roberts, Ernest Henry.....	November 4th	December 2nd.
Rosling, Edward	December 17th, 1896.	March 4th.
Rutter, Alfred	January 21st.....	" "
Scargill, Lionel Walter K., B.A.	May 20th	June 17th.
Shenton, James Porter.....	" "	" "
Simpson, Edward Sydney, B.E.....	November 4th	December 2nd.
Smith, Robert Francis Wood	" "	" "
Southerden, Frank	November 19th, 1896	March 4th.
Southern, Thomas, junr.	June 3rd.....	December 2nd.
Stainer, William James, B.A.	December 3rd, 1896 ..	March 4th.
Steel, Frederick William.....	November 4th	December 2nd.
Stephens, Michael Edmund.....	" "	" "
Stevens, Henry Potter, B.A.	December 17th, 1896.	March 4th.
Stubbs, George	November 4th	December 2nd.
Sumner, Leonard, B.Sc.	January 21st.....	March 4th.
Taverner, William.....	April 29th.....	June 17th.
Thompson, Harry	December 17th, 1896.	March 4th.
Tickle, Thomas	March 18th ..	May 6th.
Tripp, Edward Howard, Ph.D.	November 4th	December 2nd.
Turnbull, Andrew, Ph.D.	January 21st	March 4th.
Turner, Basil William	November 19th, 1896	" "
Turner, John Scriven	November 4th.....	December 2nd.
Unwalla, Rustomji Navroji.....	January 21st	March 4th.
Viccajee, Framjee Khurshedjee	November 4th	December 2nd.
Vinter, Percy John, M.A.	" "	" "
Waite, William Herbert, B.A.....	February 18th	May 6th.
Walford, Samuel Matthew	December 3rd, 1896..	March 4th.
Walker, J. Wallace, M.A., Ph.D.....	" "	" "
Watts, Charles Thomas Foster	February 18th.....	May 6th.
Welsh, John	" "	" "
West, Charles Alfred	April 1st.....	" "
While, Arthur James	November 4th	December 2nd.
White, Paul Thomas.....	April 1st	May 6th.
Wilderman, Meyer, Ph.D.	February 4th	March 4th.
Young, Francis Samuel, M.A.	June 3rd.....	December 2nd.

FELLOWS DECEASED.

Name.	Elected.	Died.
Bowrey, J. J.	December 16th, 1869	November 19th 1897.
Child, G. W.	January 16th, 1868.....	
Gaskell, E. H.....	January 20th, 1876	November 18th, 1897.
Gibbins, B. H.....	May 7th, 1891.....	May 8th, 1897.
Hammersley, W. A. L. ...	December 7th, 1882	December 26th, 1897.
Harris, S. J.	December 2nd, 1886	May 27th, 1897.
Jardine, Walter	February 18th, 1894	
Keyworth, G. A.....	April 15th, 1875.....	May 27th, 1897.
Lackersteen, M. H.	February 3rd, 1859.....	December 7th, 1897.
Lees, Samuel	December 1st, 1887	April 17th, 1897.
Lescher, Herman.....	April 17th, 1890	March —, 1897.
Mitchell, Thomas	June 18th, 1891	September 9th, 1897.
Newton, Howard	December 18th, 1879	July 27th, 1897.
Rimington, F. M.	December 4th, 1873	June 17th, 1897.
Rodger, J. W.	December 15th, 1892	May 30th, 1897.
Roy, Taraprasanna.....	June 17th, 1880	
Saint, W. J.....	December 20th, 1883.....	May 11th, 1897.
Tomlinson, Charles.....	June 2nd, 1864	February 12th, 1897.
Wormley, T. G.	November 19th, 1885.....	January 3rd, 1897.

TITLES OF PAPERS COMMUNICATED TO THE SOCIETY DURING 1897.

	Page in Pro- ceedings.	Page in Trans- actions.
<i>January 21st.</i>		
1. Observations on the properties of some highly purified substances. By W. A. Shenstone	2	471
2. The action of diastase on starch. By Arthur R. Ling and Julian L. Baker.....	3	508
3. The solution density and cupric-reducing power of dextrose, levulose and invert-sugar. By Horace T. Brown, F.R.S., G. Harris Morris, Ph.D., and J. H. Millar.....	4	275
4. Derivatives of maclurin. Part II. By A. G. Perkin....	5	186
5. Halogen-substituted acidic thiocarbimides and their derivatives; a contribution to the chemistry of the thiohydantoins. By Augustus Edward Dixon, M.D.	6	617
6. The amyl (secondary butyl-methyl) derivatives of glyceric, diacetylglyceric, and dibenzoylglyceric acids, active and inactive. By Percy Frankland, Ph.D., B.Sc., F.R.S., and Thomas Slater Price, B.Sc.....	9	253
7. The refraction constants of crystallised salts. By Alfred E. Tutton.....	10	235
8. The refraction constants of crystalline salts: A correction. By William Jackson Pope.....	11	—
9. On the wide dissemination of some of the rarer elements and the mode of their association in common ores and minerals. By W. N. Hartley, F.R.S., and Hugh Ramage.....	11	533
<i>February 4th.</i>		
10. Observations upon the oxidation of nitrogen gas. By Lord Rayleigh, F.R.S.....	17	181
11. On some apparatus for steam distillation. By F. E. Matthews, Ph.D.....	18	318
12. Researches in the Stilbene Series. I. By John J. Sudborough, Ph.D.....	19	218
13. Diortho-substituted benzoic acids. III. Hydrolysis of substituted benzamides. By John J. Sudborough, Ph.D., Percy G. Jackson, and Lorenzo L. Lloyd....	20	229
14. Conversion of camphoroxime into methylcamphorimine and camphenylnitramine. By M. O. Forster, Ph.D.	21	191
15. Note on Wechsler's method for the separation of fatty acids. By Arthur W. Crossley.....	21	580

	Page in Pro- ceedings.	Page in Trans- actions.
16. On the crystalline structure of gold and platinum nuggets and gold ingots. By A. Liversidge, LL.D., F.R.S.	22	1125
17. On the presence of gold in natural saline deposits and marine plants. By A. Liversidge, LL.D., F.R.S....	22	298
<i>February 18th.</i>		
18. The formation of dithionic acid in the oxidation of sulphurous acid by potassium permanganate. By T. S. Dymond and F. Hughes.	42	314
19. On the production of pyridine derivatives from ethylic β -amidocrotonate. By J. Norman Collie, Ph.D., F.R.S.	43	299
20. Sodamide and some of its substitution derivatives. By A. W. Titherley, M.Sc., Ph.D.	45	460
21. Rubidamide. By A. W. Titherley, M.Sc., Ph.D.	46	469
22. On the spectrographic analysis of some commercial samples of metals, of chemical preparations, and of minerals from Stassfurt potash beds. By W. N. Hartley, F.R.S., and Hugh Ramage.	46	547
23. Dissociation pressure of alkylammonium hydrosulphides. By James Walker, D.Sc., Ph.D., and John S. Lumsden, B.Sc., Ph.D.	48	428
24. Supposed condensation of benzil with ethyl alcohol. A correction. By Francis Robert Japp, F.R.S.	48	297
25. The viscosity of mixtures of miscible liquids. By T. E. Thorpe, F.R.S., and J. W. Rodger.	49	360
26. Magnesium nitride as a reagent. By H. Lloyd Snape, D.Sc., Ph.D.	50	526
27. The identity of Laurent's amarone with tetraphenylazine. By H. Lloyd Snape, D.Sc., Ph.D., and Arthur Brooke, Ph.D.	51	528
28. Studies on the interaction of highly purified gases in presence of catalytic agents. Part I. By Wm. French, M.A.	52	—
29. Contributions to the knowledge of the β -ketonic acids. Part III. By S. Ruheman, Ph.D., M.A.	52	323
30. Contributions to the knowledge of the β -ketonic acids. Part IV. By S. Ruheman, Ph.D., M.A., and A. S. Hemmy, B.A., M.Sc.	53	329
31. Oxidation of phenylstyrenyloxytriazole. By George Young, Ph.D.	53	311
32. Apiin and apigenin. (Preliminary notice.) By A. G. Perkin.	53	—
33. Note on the constitution of the so-called "nitrogen iodide." By J. W. Mallet, F.R.S.	55	—
<i>March 4th.</i>		
34. Some hydrocarbons from American petroleum. I. Normal and Iso-pentane. By Sydney Young, D.Sc., F.R.S., and G. L. Thomas, B.Sc.	58	440

	Page in Pro- ceedings.	Page in Trans- actions.
35. The vapour pressures, specific volumes and critical constants of normal pentane ; with a note on the critical point. By Sydney Young, D.Sc., F.R.S.....	58	446
36. On the freezing-point curves of alloys containing zinc. By C. T. Heycock, F.R.S., and F. H. Neville.....	60	383
37. The oxides of cobalt and the cobaltites. By Arthur H. McConnell and Edgar S. Hanes.....	62	584
38. A new synthesis in the sugar group. By Henry J. Horstman Fenton, M.A.....	63	375
39. The dinitrosamines of ethylene aniline, the ethylene toluidines, and their derivatives. By Francis E. Francis, Ph.D., B.Sc.....	63	422
40. Contribution to the knowledge of the β -ketonic acids. Part V. By S. Ruhemann, M.A., Ph.D., and A. S. Hemmy, B.A., M.Sc.....	64	334
41. Enantiomorphic forms of ethylpropylpiperidonium iodide. By Clare de Brereton Evans.....	64	522
42. Further note on ketopinic acid—pinophanic acid. By W. S. Gilles and F. F. Renwick.....	64	—
43. A synthesis of citric acid. By W. T. Lawrence, B.A., Ph.D.	65	457
<i>March 18th.</i>		
44. On the atomic weight of carbon. By Alexander Scott, M.A., D.Sc.....	70	550
45. On a new series of mixed sulphates of the vitriol group. By Alexander Scott, M.A., D.Sc.	71	564
46. A synthesis of camphoronic acid. By William Henry Perkin, jun., F.R.S., and Jocelyn Field Thorpe, Ph.D.	72	1169
47. Note on a method for determining melting points. By Ernest H. Cook, D.Sc.	74	—
48. Velocity of urea formation in aqueous alcohol. By James Walker, D.Sc., and Sydney A. Kay, B.Sc. ...	75	489
49. Action of alkyl haloids on aldoximes and ketoximes. By Wyndham R. Dunstan, F.R.S., and Ernest Goulding	76	573
<i>March 25th.</i>		
Pasteur Memorial Lecture. By Professor P. Frankland, Ph.D., B.Sc., F.R.S.....	79	683
<i>March 31st.</i>		
50. The hydrolysis of perthiocyanic acid. By F. D. Chattaway, M.A., and H. P. Stevens, B.A.	87	607
51. The composition of cooked fish. By Katherine I. Williams.....	88	649
52. On the oxidation products of $\alpha\gamma$ -dimethyl- α' -chloropyridine. By Emily Aston, B.Sc., and J. Norman Collie, Ph.D., F.R.S.....	89	653

	Page in Pro- ceedings.	Page in Trans- actions.
<i>April 29th.</i>		
53. On the explosion of chlorine peroxide with carbonic oxide. By H. B. Dixon, M.A., F.R.S., and E. J. Russell, B.Sc.....	99	605
54. On the decomposition of iron pyrites. By W. A. Caldecott, B.A.	100	—
55. Monochlorodiparaconic acid and some condensations. By Henry C. Myers, Ph.D.	100	614
56. Corydaline. Part V. By James J. Dobbie, M.A., D.Sc., and Fred Marsden, M.Sc., Ph.D.	101	657
57. A Bunsen burner for acetylene. By A. E. Munby, M.A.	103	—
58. The reactions between lead and the oxides of sulphur. By Henry C. Jenkins and Ernest A. Smith.....	104	666
59. X Ray photographs of solid alloys. By C. T. Heycock, F.R.S., and F. H. Neville	105	—
<i>May 20th.</i>		
60. The theory of osmotic pressure and the hypothesis of electrolytic dissociation. By Holland Crompton.....	109	925
61. Molecular rotations of optically active salts. By Holland Crompton.....	111	946
62. Heats of neutralisation of acids and bases in dilute aqueous solution. By Holland Crompton.....	111	951
63. A comparative crystallographical study of the normal selenates of potassium, rubidium, and caesium. By A. E. Tutton.	115	846
64. The platinum-silver alloys; their solubility in nitric acid. By John Spiller.....	118	—
65. Dalton's law in solutions. The molecular depression of mixtures of non-electrolytes. By Meyer Wilderman, Ph.D.....	119	743
66. The action of bromdiphenylmethane on ethyl sodacetate. By G. G. Henderson, D.Sc., M.A., and M. A. Parker, B.Sc.	119	676
<i>June 3rd.</i>		
67. On the thermal phenomena attending the change of rotatory power of freshly prepared solutions of certain carbohydrates; with some remarks on the cause of multirotation. By Horace T. Brown, F.R.S., and Spencer Pickering, F.R.S.....	129	756
68. On the thermo-chemistry of carbohydrate-hydrolysis: (I) The hydrolysis of starch by vegetable and animal diastase. (II) The hydrolysis of cane-sugar by invertase. By Horace T. Brown, F.R.S., and Spencer Pickering, F.R.S.	130	783
69. Optical inversion of camphor. By Frederic Stanley Kipping, Ph.D., D.Sc., and William Jackson Pope... ..	132	956
70. Derivatives of camphoric acid. Part II. Optically inactive derivatives. By F. Stanley Kipping, Ph.D., D.Sc., and William Jackson Pope.....	133	962

	Page in Pro- ceedings.	Page in Trans- actions.
71. Racemism and pseudoracemism. By F. Stanley Kipping, Ph.D., D.Sc., and William Jackson Pope.....	135	989
72. Note on some new gold salts of the solanaceous alkaloids. By H. A. D. Jowett, D.Sc.	136	679
73. Production of camphenol from camphor. By J. E. Marsh, M.A., and J. A. Gardner, M.A.	137	—
74. Preliminary note on the oxidation of fenchene. By J. A. Gardner and G. B. Cockburn.....	137	—
75. Apiin and apigenin. By A. G. Perkin.....	138	805
76. Rhamnazin. By A. G. Perkin and H. W. Martin.....	139	818
77. Experimental verification of van't Hoff's constant in very dilute solutions. By Meyer Wilderman, Ph.D.	139	796
78. The isomeric dibromethylenes. By Thomas Gray, B.Sc.	140	1023

June 17th.

79. Molecular refraction of dissolved salts and acids. Part II. By J. H. Gladstone, D.Sc., F.R.S., and W. Hibbert	141	822
80. On a space formula for benzene. By J. Norman Collie, Ph.D., F.R.S.	143	1013
81. On the production of some nitro- and amido-oxypico- lines. By A. Lapworth, D.Sc., and J. Norman Collie, Ph.D., F.R.S.	146	838
82. Further experiments on the absorption of moisture by deliquescent substances. By H. Wilson Hake, Ph.D.	147	—
83. The fusion point, boiling point, and specific gravity of nitrobenzene. By R. J. Friswell	147	1010
84. The action of light on a solution of nitrobenzene in concentrated sulphuric acid. By R. J. Friswell.....	148	—
85. The reduction of perthiocyanic acid. By F. D. Chattaway, M.A., and H. P. Stevens, B.A.....	149	833
86. The so-called hydrates of isopropyl alcohol. By T. E. Thorpe, LL.D., F.R.S.....	150	920
87. The carbohydrates of the cereal straws. By C. F. Cross, E. J. Bevan, and Claud Smith	150	1001
88. Studies on the constitution of tri-derivatives of naph- thalene No. 16. Conversion of chloronaphthalene- disulphonic acids into dichloronaphthalenesulphonic acids. By Henry E. Armstrong and W. P. Wynne...	152	—
89. Conversion of 1:1'-into 1:4'-dichloronaphthalene by hydrogen chloride. The products of hydrolysis of 1:1'-dichloronaphthalene-3-sulphonic acid. By Henry E. Armstrong and W. P. Wynne	154	—
90. Note on the formation of diacetanilide. By George- Young, Ph.D.	156	—
91. Derivatives of phenetol azo-phenols. By J. T. Hewitt, M.A., D.Sc., Ph.D., T. S. Moore, and A. E. Pitt ..	157	—
92. δ -Ketopinic acid and camphoic acid. By W. S. Gilles and F. F. Renwick	158	—
93. Note on stereoisomeric di-derivatives of camphor, and on nitro-camphor. By T. M. Lowry, B.Sc.....	159	—

	Page in Pro- ceedings.	Page in Trans- actions
94. The interaction of ethylene dichloride and ethylic sodiomalonate. By Bevan Lean, D.Sc., B.A., and Frederic H. Lees	160	1062
95. Hexanaphthene and its derivatives. Preliminary note. By Emily C. Fortey, B.Sc.	161	—
<i>Papers received during vacation and published in Transactions.</i>		
96. The ethers of camphor oxime. By M. O. Forster, Ph.D.	165	1030
97. The action of nitrogen trioxide and tetroxide on alcohols. Part I. By Julius Berend Cohen, Ph.D., and Harry Thornton Calvert, B.Sc.	166	1050
98. The action of nitrogen tetroxide on ortho- and para-nitrobenzylalcohol. By Julius B. Cohen, Ph.D., and William H. Harrison, B.Sc.	166	1057
99. The action of aromatic amines upon diacetyltartaric anhydride. By Julius Berend Cohen, Ph.D., and William Hudson Harrison, B.Sc.	167	1060
100. Studies on citrazinic acid. Part V. By W. J. Sell, M.A., and F. W. Dootson, B.A.	167	1068
101. The condensation of chloral with resorcinol. II. By J. T. Hewitt, M.A., D.Sc., and Frank G. Pope	167	1084
102. On β -oxycellulose. By Benjamin Samuel Bull, M.A., B.Sc.	168	1090
103. A new synthesis of phloroglucinol. By David S. Jerdan, B.Sc.	168	1106
104. Phenanthrene. By Francis R. Japp, F.R.S., and Alexander Findlay, M.A., B.Sc.	169	1115
105. The yellow colouring principles of various tannin matters. IV. By A. G. Perkin	170	1131
106. Ammonia and phenylhydrazine derivatives of $\alpha\beta$ -dibenzoylcinnamene (anhydracetophenonebenzil). By Francis R. Japp, F.R.S., and Alfred Tingle, B.Sc.	170	1138
107. Derivatives of cotoin and phloretin. By A. G. Perkin and H. W. Martin.	171	1149
108. Azobenzene derivatives of phloroglucinol. By A. G. Perkin	172	1154
109. The action of phosphorus pentachloride on fenchone. By J. Addyman Gardner, M.A., and G. B. Cockburn, B.A.	173	1156
110. Ketolactonic acid and its homologues. By C. H. G. Sprankling, B.Sc.	173	1159
<i>November 4th.</i>		
111. On the properties of liquid fluorine. By Professors Moissan and Dewar	175	—
112. The liquefaction of air and the detection of impurities. By Professor Dewar	186	—
113. The absorption of hydrogen by palladium at high temperatures and pressures. By Professor Dewar	192	—

	Page in Pro- ceedings.	Page in Trans- actions.
114. On some yellow vegetable colouring matters. By A. G. Perkin	198	1194
115. Naphthylureas. By George Young, Ph.D., and Ernest Clark	199	1200
116. Benzoylphenylsemicarbazide. Preliminary notice. By George Young, Ph.D., and Henry Annable	199	—
117. Sulphocamphylic acid. By W. H. Perkin, jun.....	200	—
<i>November 18th.</i>		
118. On the decomposition of camphoric acid by fusion with potash or soda. By Arthur W. Crossley and W. H. Perkin, jun.....	217	1*
119. Experiments on the synthesis of camphoric acid. By W. H. Bentley and W. H. Perkin, jun.....	218	45*
120. Synthesis of an isomeride of camphoronic acid. By S. B. Schryver, Ph.D.	220	68*
121. The action of magnesium on cupric sulphate solution. By Frank Clowes, D.Sc., and R. M. Caven, B.Sc. ...	221	—
122. Properties and relationships of dihydroxytartaric acid. By Henry J. Horstman Fenton, M.A.	224	71*
123. The molecular association of liquids and its influence on the osmotic pressure. By Holland Crompton.....	225	—
<i>December 2nd.</i>		
124. The representation of the isomeric benzene hexachlorides by Collie's space-formula. By Francis Edward Matthews, Ph.D.....	232	
125. Compounds of piperidine with phenols. By Otto Rosenheim, Ph.D., and Philip Schidrowitz, Ph.D....	234	139*
<i>December 15th.</i>		
Kekulé memorial lecture. By Professor Francis R. Japp, LL.D., F.R.S.	235	97*
<i>December 16th.</i>		
126. Stereochemistry of unsaturated compounds. Part I. Esterification of substituted acrylic acids. By John J. Sudborough and Lorenzo L. Lloyd.....	240	81*
127. Formation and hydrolysis of esters. By John J. Sudborough, Ph.D., D.Sc., and Martin E. Feilmann, B.Sc.....	241	—
128. A new method of determining freezing points in very dilute solution. By Meyer Wilderman, Ph.D.	245	—
129. A possible basis of generalisation of isomeric changes in organic compounds. By Arthur Lapworth, D.Sc.	246	—

* Papers printed in the Transactions for 1898 are distinguished by an asterisk after the page number. Where no reference is given to the Transactions, the paper has appeared only in the "Proceedings."

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INDEX TO AUTHORS' NAMES.

- Annable, Henry, 199.
 Armstrong, Henry E., 152, 154.
 Aston, Emily, 89.
 Baker, Julian L., 3.
 Bentley, W. H., 218.
 Bevan, E. J., 150.
 Brooke, Arthur, 51.
 Brown, Horace T., 4, 129, 130.
 Bull, Benjamin Samuel, 168.
 Caldecott, W. A., 100.
 Calvert, Harry Thornton, 166.
 Caven, R. M., 221.
 Chattaway, F. D., 87, 149.
 Clark, Ernest, 199.
 Clowes, Frank, 221.
 Cockburn, G. B., 137, 173.
 Cohen, Julius Berend, 166, 167.
 Collie, J. Norman, 43, 89, 143, 146.
 Cook, Ernest H., 74.
 Crompton, Holland, 109, 111, 225.
 Cross, C. F., 150.
 Crossley, Arthur W., 21, 217.
 Dewar, James, 175, 186, 192.
 Dixon, Augustus Edward, 6.
 Dixon, H. E., 99.
 Dobbie, James J., 101.
 Dootson, F. W., 167.
 Dunstan, Wyndham R., 76.
 Dymond, T. S., 42.
 Evans, Clare de Brereton, 64.
 Feilmann, Martin E., 241.
 Fenton, Henry J. Horstman, 63, 224.
 Findlay, Alexander, 169.
 Forster, M. O., 21, 165.
 Fortey, Emily C., 161.
 Francis, Francis E., 63.
 Frankland, Percy, 9.
 French, Wm., 52, 79.
 Friswell, R. J., 147, 148.
 Gardner, J. A., 137, 173.
 Gilles, W. F., 64.
 Gilles, W. S., 158.
 Gladstone, J. H., 141.
 Goulding, Ernest, 76.
 Gray, Thomas, 140.
 Hake, H. Wilson, 147.
 Hanes, Edgar S., 62.
 Harrison, William Hudson, 166, 167.
 Hartley, W. N., 11, 46.
 Hemmy, A. S., 53, 64.
 Henderson, G. G., 119.
 Hewitt, J. T., 157, 167.
 Heycock, C. T., 60, 105.
 Hibbert, W., 141.
 Hughes, F., 42.
 Jackson, Percy G., 20.
 Japp, Francis Robert, 48, 169, 170, 235.
 Jenkins, Henry C., 104.
 Jerdan, David S., 168.
 Jowett, H. A. D., 136.
 Kay, Sydney A., 75.
 Kipping, Frederic Stanley, 132, 133, 135.
 Lapworth, Arthur, 146, 246.
 Lawrence, W. T., 65.
 Lean, Bevan, 160.
 Lees, Frederic H., 160.
 Ling, Arthur R., 3.
 Liversidge, A., 22.
 Lloyd, Lorenzo L., 20, 240.
 Lowry, T. M., 159.
 Lamsden, John S., 48.
 Mallett, J. W., 55.
 Marsden, Fred, 101.
 Marsh, J. E., 137.
 Martin, H. W., 139, 171.
 Matthews, Francis Edward, 18, 232.
 McConnell, Arthur H., 62.
 Millar, J. H., 4.
 Moissan, Professor, 175.
 Moore, T. S., 157.
 Morris, G. Harris, 4.
 Munby, A. E., 103.
 Myers, Henry C., 100.

Neville, F. H., 60, 105.

Parker, M. A., 119.

Perkin, A. G., 5, 53, 138, 139, 170, 171, 172, 198.

Perkin, W. H., jun., 72, 200, 217, 218.

Pickering, Spencer, 129, 130.

Pitt, A. E., 157.

Pope, Frank G., 167.

Pope, William Jackson, 11, 132, 133, 135.

Price, Thomas Slater, 9.

Ramage, Hugh, 11, 46.

Rayleigh, Lord, 17.

Renwick, F. F., 64, 158.

Rodger, J. W., 49.

Rosenheim, Otto, 234.

Ruhemann, S., 52, 53, 64.

Russell, E. J., 99.

Schidrowitz, Philip, 234.

Schryver, S. B., 220.

Scott, Alexander, 70, 71.

Sell, W. J., 167.

Shenstone, W. A., 2.

Smith, Claud, 150.

Smith, Ernest, A., 104.

Snape, H. Lloyd, 50, 51.

Spiller, John, 118.

Sprankling, C. H. G., 173.

Stevens, H. P., 87, 149.

Sudborough, John J., 19, 20, 240, 241.

Thomas, G. L., 58.

Thorpe, Jocelyn Field, 72.

Thorpe, T. E., 49, 150.

Tingle, Alfred, 170.

Titherley, A. W., 45, 46.

Tutton, Alfred, E., 10, 115.

Walker, James, 48, 75.

Wilderman, Meyer, 119, 139, 245.

Williams, Katherine I., 88.

Wynne, W. P., 152, 154.

Young, George, 53, 156, 199.

Young, Sydney, 58.

INDEX TO DISCUSSIONS.

-
- Armstrong, H. E., 18, 59, 100, 105.
 Baker, H. B., 3.
 Blount, B. H., 71.
 Bloxam, A. G., 249.
 Bone, W. A., 136.
 Cassal, C. E., 89.
 Collie, J. N., 249.
 Craw, J. A., 59, 62.
 Crookes, Sir W., 100, 192.
 Dewar, James, 88, 100, 105, 107, 142, 149.
 Dunstan, W. R., 43, 89, 143.
 Forster, M. O., 44, 220.
 Friswell, R. J., 119, 145, 198.
 Gladstone, J. H., 118, 185.
 Green, A. G., 149.
 Groves, C. E., 59, 62, 71, 88, 89, 105.
 Harcourt, A. Vernon, 3, 18, 42, 59, 71, 119.
 Hehner, O., 89.
 Hewitt, J. T., 149, 244.
 Heycock, C. T., 71.
 Jenkins, H. C., 62.
 Kipping, F. S., 44, 132, 145, 220, 249.
 Lapworth, Arthur, 233.
 Ling, A. R., 132.
 McLeod, H., 18.
 Morris, G. H., 4.
 Newlands, J. A. R., 62.
 Parry, E. J., 233.
 Perkin, W. H., 184.
 Pickering, S. P. U., 112, 245.
 Ramsay, William, 18.
 Rideal, Samuel, 48.
 Roberts-Austen, W. C., 105, 106.
 Scott, Alexander, 43, 100.
 Shields, John, 114, 244.
 Spiller, John, 71.
 Sutherland, D. A., 89.
 Sworn, W. A., 145.
 Thorne, L. T., 3.
 Thorpe, T. E., 3, 59, 185.
 Tilden, W. A., 3, 145, 222.
 Whetham, W. C. D., 113.
 Wynne, W. Palmer, 232, 247.

INDEX OF SUBJECTS.

- Acetaldoxime, derivatives of, 76.
 Acetoxime, derivatives of, 77.
 α -Acetyl- β -diphenylpropionic acid, preparation and properties of, 119.
 Acetylene, a Bunsen burner for, 103.
 Acids, fatty, Wechsler's method of separating, 22.
 Acrylic acids, substituted, stereoisomeric method of distinguishing, 241.
 Affinity, residual, 113.
 Air, liquefaction of, 186.
 Alkaloids, Solanaceous, gold salts of, 136.
 Alkyl haloids, action of, on aldoximes and ketoximes, 76.
 Alkylloximes, formation and constitution of, 76.
 β -Alkylacetosuccinic ethers, hydrolysis of, 174.
 Alkylammonium hydrosulphides, dissociation pressures of, 48.
 Allylphenylthiohydantoin, preparation and properties of, 8.
 Aluminium, spectrographic analysis of, 47, 48.
 Aluminous minerals, spectrographic analysis of, 12.
 Alums, spectrographic analysis of, 47.
 Amarone, identity of, with tetraphenylazine, 51.
 American petroleum, hydrocarbons from, 58.
 Ammonia, action of, on solid iodine, 55.
 Amyl derivatives of substituted glyceric acids, 9.
 Analysis, method of spectrographic, 11, 46.
 Anhydracetophenonebenzil, derivatives of, 170.
 Anniversary meeting, 80.
 Apigenin, constitution, composition, properties and preparation of, 54, 138.
 Apiin, properties of, 53.
 Apparatus, new forms of, 3.
 — for concentration of argon from air, 18.
 — for steam-distillation, 18.
 Argon, concentration of, from air, 18.
 Association, molecular, of liquids, 225.
 — of solvent, effect of, on osmotic pressure, 227.
 Atropine, gold salts of, 137.
 Bauxites, spectrographic analysis of, 12.
 Benzamides, hydrolysis of substituted, 20.
 — new substituted, 21.
 Benzene, a space formula for, 143.
 — hexachlorides and the space formula, 232.
 — substitution in, explanation of, 144.
 Benzil, preparation of, from benzoin, 20.
 — condensation product: a correction, 48.
 Benzoylphenylsemicarbazide, properties of, 199.
 Benzoic acids, di-ortho-substituted, Part III, 20.
 Benzylphenylthiohydantoin, preparation and properties of, 8.
 Black band ores, spectrographic analysis of, 12.
 Blendes, spectrographic analysis of, 13.
 di-Bromethylenes, the isomeric, 140.
 π -Bromocamphoric acid, inactive, preparation and properties of, 134.
 Bromodihydro- β -camphylic acid, 200.
 Budde's experiments on the expansion of chlorine, 3.
 "Bumping" of boiling liquids, how stopped, 19.
 iso-Butylhydroxycyanovaleic acid, preparation and properties of, 219.
 iso-Butylmethylhydroxyglutaric acid, preparation of, 219.
 Calcium present in aluminium, origin of, 48.
 cis- π -Camphanic acid, inactive, preparation and properties of, 134.
 trans- π -Camphanic acid, inactive and active, preparation and properties of, 134.
 Camphenol, production of, from camphor, 137.

- Camphenylnitramine, preparation and properties of, 21.
 Camphoric acid and ketopinic acid, 65, 158.
 Camphor, optical inversion of, 132.
 ————— stereoisomeric di-derivatives of, 159.
 Camphoric acid, formula for, 218.
 ————— synthesis of, 218.
 ————— decomposition of, 217.
 ————— derivatives of, 11, 133.
 ψ -Camphoric acid, preparation and properties of, 218.
 Camphoronic acid, synthesis of, 72.
 ————— an isomeride of, 220.
 Camphoroxime, ethers of, 165.
 Camphotricarboxylic acid and ketopinic acid, 63.
trans-Camphotricarboxylic acid, inactive, preparation and properties of, 135.
 Cannizzaro, Professor, reply of, to Society's Address, 1.
 Carbohydrates of cereal straws, 150.
 ————— thermochemistry of change of rotatory power of, 129.
 Carbon, optical effects of asymmetric, 9.
 ————— atomic weight of, 70.
 Carbon monoxide, action of "nascent" oxygen on, 99.
 ————— completely absorbed by potash, 71.
 Carbon dioxide, expansion of potash solution by absorption of, 71.
 Catalytic agents, interaction of highly-purified gases in presence of, 52.
 Certificates of candidates for election, 25, 55, 91, 123, 206.
 Chloral, condensation of, with resorcinol, II, 167.
 Chlorine, behaviour of pure dry, under the silent discharge, 2.
 ————— anomalous expansion of, 3.
 ————— action of pure dry, on mercury, 3.
 Chlorine peroxide, explosion of, with carbonic oxide, 99.
 $\alpha\alpha$ -Chlorobromocamphors, two isomeric, 159.
 π -Chlorocamphoric acid, inactive, preparation and properties of, 134.
 Chlorodihydro- β -camphylic acid, 200.
 Chlorodiparaconic acid, preparation and properties of, 100.
 Chlorofenchone phosphonic acid, preparation and properties of, 173.
 α -Chloro- γ -methyl- α' -pyridinecarboxylic acid, preparation and properties of, 89.
 α -Chloro- α' -methyl- γ -pyridinecarboxylic acid, preparation and properties of, 89.
 :4'-*di*-Chloronaphthalene, preparation of, 154.
di-Chloronaphthalenesulphonic acids, 152.
 2 : 4'-*di*-Chloronaphthalene-2'-sulphonic acid, preparation and properties of, 153.
 2 : 1'-*di*-Chloronaphthalene-3'-sulphonic acid, 153.
 1 : 1'-*di*-Chloronaphthalene-3-sulphonic acid, preparation and properties of, 155.
 Chlorostilbene, a new, from deoxybenzoin, 20.
 Citrazinic acid : studies on, Part V, 167.
 Citric acid, synthesis of, 65.
 Clay ironstones, spectrographic analysis of, 12.
 Cobalt ores, spectrographic analysis of, 13.
 Cobalt, oxides of, and cobaltites, 62.
 Cobaltous acid, properties of, 62.
Colpoony compressum, glucosides from, 170.
 Commemoration Medal granted to President, 217.
 Corydaline, Part V, 101.
 Corydic acid, preparation and properties of, 101.
 Cotoin, diazobenzene derivatives of, 172.
 Curtius' compound, identical with sodium benzamide, 46.
 Dalton's law in solutions, 119.
 Deliquescent substances, absorption of water by, 147.
 Dextrose, solution-density and cupric reducing power of, 5.
 Diacetanilide, formation of, 156.
 Diacetyltartaric anhydride, action of aromatic amines, 167.
 Diastase, hydrolysis of starch by, 130.
 ————— products of the action of, on starch, 3.
 Dihydrocamphoketone, preparation and properties of, 218.
 Dihydrocamphoric acid, preparation and properties of, 218.
 Dihydro-*iso*-lauronic acid, preparation of, 201.
 Dihydroxymaleic acid and its isomeride, 224.
 Dihydroxytartaric acid, preparation and properties of, 224.
 $\alpha\gamma$ -Dimethyl- α' -chloropyridine, oxidation products of, 89.
 Dimethylphenylthiohydantoin, preparation and properties of, 9.
 Dithionic acid from sulphurous acid, 42.
 Electrical conductivity, theory of, in liquids, 112.
 Electric flame, oxidation of nitrogen by, 18.
 Electrolytic dissociation, hypothesis of, 109.
 ————— reduction of a sulphuric acid solution of nitrobenzene, 149.

- Ellagic acid, plants of which it is the colouring matter, 170.
- Enantiomorphism of ethylpropylpiperidonium iodide, 64.
- Esterification of unsaturated acids, 240 *seq.*
- Esters, formation and hydrolysis of, 241.
- rate of hydrolysis of, 242-3.
- α -Ethyladipic acid, 161.
- α -Ethylbutanetricarboxylic acid, preparation and properties of, 161.
- Ethyleneaniline and toluidine, dinitrosamines of, 63.
- Ethylic acetosuccinate, colour reaction of, 53.
- some derivatives of, 53.
- Ethylic acetyl-*iso*-butylsuccinate, preparation and properties of, 219.
- α -acetyl- β -diphenylpropionate, preparation and properties of, 119.
- adipate, 161.
- alcohol, action of, in formation of urea from ammonium cyanate, 75.
- anhydro-oxalacconitate and its isomeride, 64.
- benzoylsuccinate, properties of, 53.
- brom-*iso*-butylacetate, properties of, 219.
- butanetricarboxylate, 161.
- α -chlorocrotonate, action of, on β -ketonic acids, 52.
- chlorofumarate, action of, on β -ketonic acids, 52.
- β -chlor- $\alpha\beta$ -trimethylglutarate, preparation and properties of, 73.
- β -cyano- $\alpha\beta$ -trimethylglutarate, preparation and properties of, 73.
- α -ethylbutanetricarboxylate, preparation and properties of, 161.
- β -hydroxy- $\alpha\beta$ -trimethylglutarate, preparation and properties of, 72.
- pyronetricarboxylate and its isomeride, 64.
- sodacetoacetate, derivatives of, 119.
- sodimalonate and ethylene dichloride, interaction of, 160.
- Ethylphenylthiohydantoin, preparation and properties of, 9.
- Ethylpropylpiperidonium iodide, enantiomorphic forms of, 64.
- Ethyl-*o*-tolylthiohydantoin, preparation and properties of, 9.
- Fellows, election of, 57, 102, 141, 231.
- Fenchene, oxidation of, 137.
- Fenchone, action of phosphorus pentachloride on, 173.
- Ferrous sulphide in the decomposition of iron pyrites, 100.
- Fisetin, colouring matter of *Rhus rhodantha*, 198.
- Fish, cooked, composition of, 88.
- Fluorine, properties of, at a low temperature, 183.
- refractive index of, 183, 185.
- magnetic rotation of, 184 *seq.*
- critical point of, 177.
- liquifying point of, 178 *seq.*
- properties of liquid, 175 *seq.*
- capillary constant of liquid, 181.
- density of liquid, 180 *seq.*
- Foreign Members, proposal of, 240.
- Formaldoxime, derivatives of, 76.
- Freezing points in dilute solution, determination of, 245.
- Fumaroid linking of carbons in benzene compounds, 233.
- Furfuroids in cereal straws, 151.
- Galcnas, spectrographic analysis of, 13.
- Gallium, wide occurrence of, in minerals, 13.
- Glyceric acids, amyl derivatives of substituted, 9.
- Glycollic aldehyde from dihydroxymaleic acid, properties of, 63.
- Gold, occurrence of, in natural saline deposits, 23.
- determination of, in natural saline deposits, 23.
- nuggets, crystalline structure of, 22.
- Gold-sodium alloys, crystalline structure of, 106.
- Hæmatites, brown and red, spectrographic analysis of, 12.
- Heats of neutralisation, 111.
- Helium, collection of, from Bath water, 190.
- Hexanaphthene, preparation and properties of, 161.
- Hydration of salts a cause of their deliquescence, 147.
- Hydrocarbon in gas from Bath springs, 190 *seq.*
- β -Hydroxy- $\alpha\beta$ -trimethylglutaric acid, preparation and properties of, 72.
- Hydroxyl groups in catechin and cyanomac lurin, estimation of, 5.
- Hyoscine gold salts, 137.
- Hyoscyamine gold salts, 137.
- Invertase, hydrolysis of cane-sugar by, 131.
- Invert-sugar, solution-density, and cupric-reducing power of, 5.
- Iron pyrites, decomposition of, 100.
- Kekulé Memorial Lecture, 235.
- Ketolactonic acid and its homologues, 173.

β -Ketonic acids. Parts III, IV, V, 52, 53, 64.
 Ketopinic acid and its derivatives, 64.
 δ -Ketopinic acid, properties of, 158.
 Lævulose, solution-density, and cupric-reducing power of, 5.
 Laurent's "amarone," preparation and properties of, 51.
iso-Lauronic acid, properties of, 201.
iso-Lauronic and *iso*-lauronic acids, constitution of, 202.
 Lead, action of oxides of sulphur on, 104.
 ——— metallurgy of, 104.
 Liebisch's rule for distinguishing mixtures and racemic compounds, 136.
 Light, lecture illustration of chemical effect of, 149.
 Limonites, spectrographic analysis of, 12.
 Longstaff Medal, award of, 42, 80.
 ψ -Lutidostyryl, products of the interaction of, with phosphorus pentachloride, 44.
 Maclurin, derivatives of, 5.
 Magnesium, action of, on cupric sulphate solution, 221.
 Magnesium nitride, action of, on organic compounds, 50.
 Magnesium-copper couple, action of, on water, 223, 224.
 Magnetites, spectrographic analysis of, 12.
 Maleoid linking of carbons in benzene compounds, 233.
 Maltodextrin, α - and β -, properties of, 3.
 Manganese ores, spectrographic analysis of, 12.
 ——— sulphate, use in oxidising sulphurous acid, 42, 43.
 Melting points, method of determining, 74.
 Memorial Lecture, Kekulé, 235.
 ——— Pasteur, 79.
 Mercury and chlorine, interaction of pure, 3.
 Methylcamphorimine from camphoroxime, preparation and properties of, 21.
 Methylphenylthiohydantoin, preparation and properties of, 8.
 Methyl-*o*-tolylthiohydantoin, preparation and properties of, 8.
 Minerals, aqueous origin of many, 13.
 Moisture, influence of, on production of ozone, 2.
 Monoses, the carbohydrates of cereal straws, 151.
 Multirotation, cause of, 129.

Myricetin, colouring matter of Venetian sumach, 170.
 Naphthalene, tri-derivatives of, 153 *seq.*
 Naphthylureas, preparation and properties of, 199.
 Nickel ores, spectrographic analysis of, 13.
 Nicotinic acids, substituted, 167.
 Nitric acid, action of, on platinum-silver alloys, 118.
 Nitrobenzene, some physical constants of, 147.
 ——— solution in sulphuric acid, action of light on, 148.
 Nitrobenzylic alcohol, *o*- and *p*-, action of nitrogen tetroxide on, 166.
 Nitrocamphor, preparation and properties of, 160.
 Nitrogen gas, oxidation of, 17.
 ——— iodide, composition of, 55.
 ——— *tri*- and *tetroxide*, action of, on alcohols, 166.
 ——— *tetroxide*, action of, on nitrobenzylic alcohols, 166.
 Nomination for President, 69.
 Non-electrolytes, molecular depression of mixtures of, 119.
 Officers and Council, changes in, 41.
 "Optical antipodes," 133.
 Optical effects of asymmetric carbon in glycerates, 9.
 Organic compounds, isomeric changes in, 246.
 Osmotic pressure, theory of, 109.
 ——— and association, 225.
 Osyritin, from Cape sumach, 170.
 β -Oxycellulose, derivatives of, 168.
 Oxygen, behaviour of, under the silent discharge, 2.
 Oxypicolines, some nitro- and amido-, 146.
 Ozone, conversion of oxygen into, under the silent discharge, 2.
 ——— unstable in contact with an alkali, 3.
 Palladium, absorption of hydrogen by, 192.
 Palladium-hydrogen, latent heat of dissociation of, 197.
 Pasteur Memorial Lecture, 79.
 Pentane and *iso*-pentane from American petroleum, 58.
 ——— physical constants of, 58.
 ——— fractionation of, 60.
 Perthiocyanic acid, hydrolysis of, 87.
 ——— reduction of, 149.
 Phenanthrone, constitution of, 169.
 β -Phenanthrylamine, formation of, 169.

- β -Phenanthrylic acetate, formation of, 169.
 β -Phenanthrylic oxide, formation of, 169.
 o -Phenetolazophenol, o - and p -, preparation, properties and derivatives of, 157.
 o -Phenetolazophenyl benzoate, properties of, 157.
 p -Phenetolazophenyl acetate and benzoate, properties of, 158.
 o -Phenetolazophenylbenzene, properties of, 157.
 p -Phenetolazophenylbenzene sulphonate, properties of, 158.
 Phenylethoxytriazole carboxylates, properties of, 53.
 Phenylstyrenyloxytriazole, oxidation of, 53.
 Phloretin, diazobenzene derivatives of, 172.
 Phloroglucinol, synthesis of, 163.
 ————— azobenzene derivatives of, 172.
 Phloroglucinoldisazobenzene- m -azonitrobenzene, preparation and properties of, 173.
 Phloroglucinol- o -trisazoanisole, preparation and properties of, 172.
 Phloroglucinol-trisazobenzene, preparation and properties of, 172.
 Phosphorus in cooked fish, 89.
 ————— pentachloride as an agent for replacing the sulphonic radical by chlorine, 152.
 Photography, use of trioxypicoline in, 146.
 Pinophanic acid from ketopinic acid, 65.
 Piperidine, compounds of, with phenols, 234.
 Platinum nuggets, crystalline structure of, 22.
 Platinum-silver alloys, solubility of, 118.
 Potassium ethylamide, preparation and properties of, 45.
 Pressure, partial, of dissolved gases, 226.
 Prior's "achroodextrin III," 3.
iso-Propyl alcohol, "hydrates" of, 150.
 "Pseudo-racemism," 135.
 Pyridine derivatives from the distillation of ethylic β -amido-crotonate, 43.
 Pyridine-benzene formula, 239.
 Pyrites, spectrographic analysis of, 13.

 Racemism and pseudo-racemism, 135.
 Refraction constants of crystalline salts, 10, 11.
 ————— substances having two indices of, 141.
 Refraction, molecular, of dissolved salts and acids, 141.
 Research Fund, donation of 1,000 guineas, 24.
 Resorcinol, condensation of chloral with, 11, 167.
 Rhamnazin, constitution and properties of, 139.
Rhus rhodanthema, colouring matter of, 198.
 Rotation, molecular, of optically active salts, 111.
 ————— specific, always constant for the same substance, 142.
 Rubidamide, preparation and properties of, 46.

 Saline deposits, occurrence of gold in, 23.
 Selenates of potassium, rubidium, and caesium, crystallography of, 115.
 Siderites, spectrographic analysis of, 12.
 Silver-platinum alloys, solubility of, 118.
 Sodamide, reaction of, with organic substances, 45.
 ————— substitution derivatives of, 45.
 ————— constitution of substituted, 46.
 Sodium-gold alloys, crystalline structure of, 106.
 Solvents, associated or monomolecular, 110.
 Starch, products of the action of diastase on, 3, 130.
 Stassfurt minerals, spectrographic analysis of, 47.
 Statistics of Society, 81.
 Stereochemistry of unsaturated compounds, I, 240.
 Substances, pure, properties of some, 2.
 Sugar, new synthesis of a, 63.
 Sulphates, mixed, of the vitriol group, 71.
 Sulphocamphylic acid, derivatives of, 200.
 Sulphurous acid, titration of, by permanganate, 42.
 Sumach, Cape and Venetian, colouring matters of, 170.

 Temperature, influence of, on rotation, 10.
 Tetraphenylazine, identity of, with amaron, 51.
 Tetraphenylenefurfuran, formation of, 169.
 Thermal effects attending change of rotatory power, 130.
 Thermochemistry of carbohydrate hydrolysis, 130.
 Thiohydantoins, chemistry of, 6.
 ————— nomenclature of, 9.
 Tin ores, spectrographic analysis of, 13.
 Toluene, nitration of, 145.

- Toluidine and ethylenedianiline, dinitrosamines of, 63.
o-Tolylthiohydantoin, preparation and properties of, 8.
 Triacetylmaclurinazobenzene, preparation and properties of, 5.
 $\alpha\alpha\beta$ -Trimethylglutaconic acid, preparation and properties of, 72.
 $\alpha\alpha\beta$ -Trimethylglutaric acid, preparation and properties of, 72.
 $\alpha\alpha\beta$ -Trimethyltricarballic acid, 73.
 Trioxypicoline, preparation and properties of, 146.
 Triphenylhydroxypyrrholone, formation and properties of, 171.
 1:3:4-Triphenylpyrazole, formation of, 171.
 Triphenylpyrrhole, formation of, 171.
 Tustin, Mr., Donation to Research Fund of 1,000 guineas, 24.
 Urea formation, velocity of, in aqueous alcohol, 75.
 Van't Hoff's constant in dilute solutions, 139.
 Viscosity of mixtures of miscible liquids, 49.
 ————— numbers proposed as a test of identity, 59.
 Water, ultra-violet spectrum of, as test for presence in flames, 100.
 Wechster's method of separating fatty acids, 21.
 Wein's reduction tables, correction of, 3.
 X-ray photographs of solid alloys, 105.
 X-rays, opacity of elements to, relation of, to atomic weights, 107.
 Zinc alloys, freezing point curves of, 60.
 Zinc-platinum couple for stopping "bumping," 19.

ERRATA.

Page.	Line.	
42	7	for "dithonic" read "dithionic."
65	24	„ "Laurence" read "Lawrence."
89	34	„ " α -chloro- α -methyl- α' -pyridine carboxylic acid" read " α -chloro- α' -methyl- γ -pyridine carboxylic acid."
119	12	„ "impurities" read "sulphuric acid."

PROCEEDINGS

OF THE

CHEMICAL SOCIETY.

EDITED BY THE SECRETARIES.

No. 173.

Session 1896-7.

January 21st, 1897. Mr. A. G. Vernon Harcourt, President, in the Chair.

Messrs. Charles A. Hill, Arthur Marshall and William H. Sodeau were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. William Arbuckle, 34 Moore Street, Cadogan Square, S.W. ; Masumi Chikashigé, B.Sc., Kumamoto, Japan ; Alfred Foster Cholerton, Lyndum House, Lincoln Street, Leicester ; Clarence Hamilton Creasey, 78 Baggeholme Road, Lincoln ; James Crowther, B.Sc., West Field, Lightcliffe, Halifax ; William Alfred Davis, 108 Gordon Road, Peckham, S.E. Ernest Goulding, 18 Mercer's Road, Holloway, N. ; Charles Heppenstall, Ferrybank, Arklow, Co. Wicklow ; Harold Johnson, 5 Boulevard Clovis, Bruxelles ; William Robert Lang, B.Sc., 5 Crown Gardens, Glasgow ; Barker North, 3 Manor Terrace, Felixstowe ; Herbert Spindler Pullar, Rosebank, Perth, N.B. ; William Ralston, B.Sc., 337 Cathcart Road, Glasgow ; John Stewart Remington, Dromore, Milverton, Leamington ; Leonard Sumner, B.Sc., Butt Hill, Prestwich, near Manchester ; Andrew Turnbull, Ph.D., Daldowie, Broomhouse, near Glasgow.

The certificates of the following candidates, recommended by the Council under Bye-law I (3), were also read :—

Thomas Hannibal Aquino, Gadag, Dharwar District, India. Alfred Rutter, Broken Hill, N.S.W. Rustomji Navroji Unwalla, Bhaunagar, Kathiawar, India.

The following is the text of the letter which has been received from Professor Stanislao Cannizzaro, acknowledging the address presented to him by the Society on the occasion of his jubilee.

To the Council and Fellows of the Chemical Society of London.

GENTLEMEN,—I beg to offer to your Society the report of the celebration of my seventieth birthday, together with the volume containing

it gave a small amount of crystalline osazone, it perhaps contained maltose.

When the three substances above named are treated with an excess of diastase at 60° for a few hours, the approximate reducing powers of the products are $R = 90$; 91.5 ; 94 , respectively.

There are now ample data to conclude that starch, when hydrolysed by diastase, is converted into a series of maltodextrins of gradually decreasing molecular weight and optical rotatory power, and of increasing reducing power. These appear to have the optical and reducing properties of mixtures of the original starch and maltose.

DISCUSSION.

Dr. G. H. MORRIS regretted that Messrs. Ling and Baker had given no particulars of the substances they described beyond the constants $[\alpha]_D$ and R . He had therefore no means of judging whether the substances agreed with the maltodextrin described by Mr. H. T. Brown and himself, nor was it possible to follow the authors' line of work. The constants given for maltodextrin α agreed fairly with the law of definite relation as formulated by Mr. Brown and himself ; but the maltodextrin β (Prior's achroodextrin III) did not, and the purity of this substance is therefore doubtful. He wished to learn more about the unfermentable residue of isomaltose, which the authors appeared to regard as one of the end-products of the action of diastase on starch. He did not think it necessary to enunciate a new theory of starch-conversion whilst there was still so much dispute as to facts.

Mr. LING, in reply to Mr. CHAPMAN, said he saw no reason for assuming the presence of a "stable" dextrin among the products of starch-hydrolysis ; ultimately maltose was the sole product. In reply to Dr. MORRIS, he said that much more information would be found in the paper than it had been possible to give an account of in the brief time at his disposal. It would be seen that the formulæ of the maltodextrins could *not* be calculated from the percentages of apparent maltose which they yielded.

***3. "The solution density and cupric-reducing power of dextrose, lævulose and invert-sugar." By Horace T. Brown, F.R.S., G. Harris Morris, Ph.D., and J. H. Millar.**

The authors have extended the methods described in their previous paper (Proc., 1896, 12, 241) to the examination of the solution density and cupric-reduction of dextrose, lævulose, and invert-sugar. They find that the solution densities of the two former differ considerably with the same concentration of the solution, but that the volume occupied in solution by a unit of weight of each is less at lower than at higher concentrations, consequently the divisor to be applied to the

specific gravity decreases with the concentration. The solution density of invert-sugar was calculated from those of dextrose and lævulose, and the results so obtained were confirmed at various points by direct experiments.

They also find that the cupric-reducing powers of the three sugars, when determined under their standard conditions, are, for dextrose, $\kappa = 117$ to 105 ; for lævulose, $\kappa = 107.5$ to 101 ; and for invert-sugar, $\kappa = 111$ to 103 . The higher numbers are obtained when a small amount of cuprous oxide is precipitated, and the lower when reduction is carried nearly to the maximum. When the experimental numbers are expressed in the form of a curve, it is found that at the one end, taking the cupric-reduction of dextrose at 100 , lævulose is represented by 91.3 , and invert-sugar by 94.2 ; at the other end of the curve, the ratio is 100 , 94.6 , and 97.5 ; whilst at an intermediate point, which corresponds to the amount of cuprous oxide usually reduced, the relation is, dextrose 100 , lævulose 92.3 , and invert-sugar 96.15 .

4. "Derivatives of maclurin, Part II." By A. G. Perkin.

From maclurin which yields a pentabenzoyl derivative (König and Kostanechi, *Ber.*, 1894, 27, 1996), a pentacetyl compound has not yet been obtained, for by acetylation in the ordinary way only sticky products result, and when excess of sodium acetate is employed (Ciamician and Silber, *Ber.*, 1894, 27, 1628), there is formed a peculiar substance having the composition of pentacetyl maclurin less 1 molecule of water. Judging from the stability of maclurin-azo-benzene, $C_{13}H_8O_6(N_2 \cdot C_6H_5)_2$, described in a previous communication (Bedford and Perkin, *Trans.*, 1895, 67, 933), when compared with that of maclurin itself, it appeared probable that this on acetylation might behave normally, which was found to be the case.

Triacetyl-maclurin-azobenzene, $C_{13}H_5O_6(C_2H_3O)_3(N_2 \cdot C_6H_5)_2$, orange-yellow needles, m. p. $240-243^\circ$, is insoluble in cold alkaline solutions, but decomposed by them on boiling. Suspended in acetic acid and treated with sulphuric acid, a quantitative yield of maclurin-azobenzene is produced. Phloroglucin-azobenzene similarly yields a *monacetyl* derivative, $C_6H_3O_3(C_2H_3O)(N_2 \cdot C_6H_5)_2$, orange-red needles, m. p. $222-223^\circ$, also quantitatively decomposed by sulphuric acid into the azo-compound. These substances furnished no higher acetyl derivatives, two hydroxyls present in the original molecules of maclurin and phloroglucinol having assumed in their diazobenzene compounds the ketonic condition. This method is being applied for the estimation of hydroxyl groups in certain analogous substances, particularly catechin and cyanomaclurin, which combine readily with diazobenzene, but do not give normal products on acetylation by the usual method.

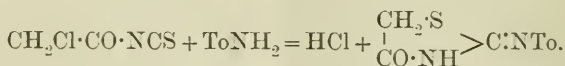
Mention is made of a second product closely resembling luteolin

trimethyl ether, and formed at the same time, during the methylation of luteolin. This, though isolated many months since, was not mentioned at the time, believing that the work then published was sufficient to establish priority for the further study of this reaction. The author wishes to reserve this to himself for further examination.

5. "Halogen-substituted acidic thiocarbimides and their derivatives; a contribution to the chemistry of the thiohydantoins."
By Augustus Edward Dixon, M.D.

Continuing his previous work on the acylylthiocarbimides (*Trans.*, 1895, 67, 1040; 1896, 69, 855; *ibid.*, 1593, etc.), the author endeavoured to prepare halogen substitution derivatives of certain members of the fatty acid class, in the hope that, by combination with organic bases, glycolylthioureas would be obtained of known structure, whose relations to the thiohydantoins produced by other methods would serve to decide the constitution of the latter.

The derivatives in question were obtained by heating a mixture of sand and lead thiocyanate with the α -halogenised acid chloride (or bromide), dissolved in anhydrous toluene; as a rule, the yield amounted to only about 60 per cent. of the theoretical. On bringing the products into contact with primary (or secondary) amines, interaction occurred spontaneously, with elimination of the halogen, and formation of the corresponding substituted thiohydantoin, for instance—

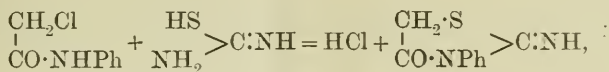


By prolonged boiling with hydrochloric acid, the latter compound is hydrolysed, ammonia being formed, together with a substance (melting at 119—120°), identical with the 'orthotolylthiocarbimidoglycolide' obtained by Völtzkow (*Ber.*, 1880, 13, 1580) from EtOH, ToNCS and $\text{CH}_2\text{Cl}\cdot\text{COOH}$. Since the nitrogenised organic group, introduced by the base in the formation of the thiohydantoin, does not form an integral portion of its ring, whilst, on the other hand, the nitrogen withdrawn by hydrolysis holds no organic radicle in combination, it follows that the ring must exchange its NH for oxygen, thereby

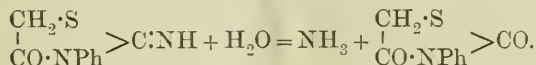
becoming $\begin{array}{c} \text{CH}_2\cdot\text{S} \\ | \\ \text{CO}\cdot\text{O} \end{array} > \text{C:NTo}$; thus, by an entirely different method, the formula is corroborated, which Evers assigns to the corresponding phenyl derivative (*Ber.*, 1888, 21, 975). From orthotolylthiourea and ethylic chloracetate, a thiohydantoin was obtained, agreeing in properties with that produced from the thiocarbimide; on hydrolysis, it afforded the same glycolide, of m. p. 119—120°.

On the other hand, thiourea, when treated with a substituted chloracetamide (*e.g.*, chloracetanilide) yielded (P. Meyer, *Ber.*, 1877, 10,

1965) thiohydantoïn, together with a substitution derivative: the phenylthiohydantoïn so obtained was apparently identical with that produced from phenylthiourea and ethylic chloracetate. The essential interaction he explained substantially as follows.

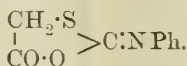


and the fact that ammonia and phenylthiocarbimidoglycolide were formed on hydrolysis, appeared to agree satisfactorily with the above view of its constitution, as well as to fix that of the glycolide,

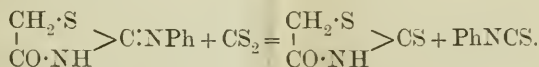


It would seem, however, from Meyer's paper, that the particular phenylthiohydantoïn obtained from chloracetanilide was not used in preparing the related phenylthiocarbimidoglycolide; it was conceivable, therefore, that the former might, though melting at the same temperature, be really isomeric with that produced by the other methods. This could be ascertained by examining the products of hydrolysis, for the withdrawal from the ring of its nitrogenised group would afford aniline, together with 'thiocarbimidoglycolide,' $\begin{array}{c} \text{CH}_2\cdot\text{S} \\ | \\ \text{CO}\cdot\text{O} \end{array} > \text{C:NH}$; whilst, even if the phenyl group should be retained,

and ammonia formed instead, the product, $\begin{array}{c} \text{CH}_2\cdot\text{S} \\ | \\ \text{CO}\cdot\text{NPh} \end{array} > \text{CO}$, would still be an isomeride of the true phenyl thiocarbimidoglycolide,



But, on experiment, the products of hydrolysis, and hence the thiohydantoïn itself, were found to be identical with those obtained in other ways. Finally, the compound was decomposed by carbon disulphide at 180°, phenylthiocarbimide being obtained, together with rhodanic acid, but not a trace of thiocyanic acid; and hence the interaction follows the course



The author therefore regards the known monosubstituted thiohydantoïns in which the radicle is attached to nitrogen, as constituted on the type, $\begin{array}{c} \text{CH}_2\cdot\text{S} \\ | \\ \text{CO}\cdot\text{NH} \end{array} > \text{C:NR}$; and suggests that the formation of the phenylic member from thiourea and chloracetanilide may be due to a

secondary action, for thiohydantoin is also produced, together with aniline,



and from these, by mutual interaction, ammonia and phenylthiohydantoin might result. Ammonia was, in fact, expelled, when aniline and thiohydantoin were heated together, with alcohol; and a substance produced, which appeared, judging from its melting point, to be its phenylic derivative, but the quantity obtained was insufficient for analysis.

The following compounds are described :

Orthotolylthiohydantoin, $\begin{array}{c} \text{CH}_2\cdot\text{S} \\ | \\ \text{CO}\cdot\text{NH} \end{array} > \text{C:NC}_7\text{H}_7$.—From chloracetylthiocarbimide and orthotoluidine; white prisms, melting at 144—145° (corr.). When boiled with baryta-water, it yields thioglycollic acid; by boiling, dilute hydrochloric acid, it is slowly decomposed into ammonia and ‘orthololylthiocarbimidoglycolide,’ $\begin{array}{c} \text{CH}_2\cdot\text{S} \\ | \\ \text{CO}\cdot\text{O} \end{array} > \text{C:NC}_7\text{H}_7$.

The same thiohydantoin is produced from orthotolylthiourea and ethylic monochloracetate; its *hydrochloride* melts at 212·5—213·5° (uncorr.).

Methylphenylthiohydantoin, $\begin{array}{c} \text{CH}_2\cdot\text{S} \\ | \\ \text{CO}\cdot\text{N} \end{array} > \text{C:N(CH}_3\text{)C}_6\text{H}_5$.—From the thiocarbimide and methylaniline; flattened needles, melting at 129—130° (corr.), and decomposed by boiling with caustic alkali or baryta-water, into ammonia, methylaniline, and thioglycollic acid. It is also obtained by heating *aa*-methylphenylthiourea, in alcohol, with ethylic monochloracetate; the *hydrochloride* melts at 193—194°.

Benzylphenylthiohydantoin, $\begin{array}{c} \text{CH}_2\cdot\text{S} \\ | \\ \text{CO}\cdot\text{N} \end{array} > \text{C:NPh}\cdot\text{CH}_2\cdot\text{Ph}$. From benzylaniline; it melts at 118—119°, and is decomposed by prolonged boiling with hydrochloric acid, into benzyaniline, and a substance melting at about 123—124°, probably ‘thiocarbimidoglycolide.’

Allylphenylthiohydantoin.—From allylphenylthiocarbamide and monochloracetamide, an oil was obtained; it appears to be a mixture of the two forms, $\begin{array}{c} \text{CH}_2\cdot\text{S} \\ | \\ \text{CO}\cdot\text{NAlI} \end{array} > \text{C:NPh}$ and $\begin{array}{c} \text{CH}_2\cdot\text{S} \\ | \\ \text{CO}\cdot\text{NPh} \end{array} > \text{NAlI}$.

α -Bromopropionylthiocarbimide, $\text{CH}_3\cdot\text{CHBr}\cdot\text{CO}\cdot\text{NCS}$, when treated with orthotoluidine, affords *methylorthotolylthiohydantoin*,

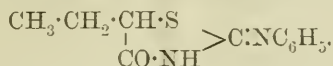


Crystalline powder, melting at 72—73°, and decomposed by boiling dilute alkali, with formation of α -thiolactic acid, $\text{CH}_3\cdot\text{CH}(\text{SH})\cdot\text{CO}_2\text{H}$.

Dimethylphenylthiohydantoïn, $\text{CH}_3 \cdot \underset{\text{CO} \cdot \text{N}}{\overset{\text{CH} \cdot \text{S}}{\text{C}}} > \text{C} \cdot \text{N}(\text{CH}_3)\text{Ph}$. From the

above thiocarbimide and methylaniline; vitreous plates, melting at 129—130°.

α-Bromobutyrylthiocarbimide, $\text{CH}_3 \cdot \text{CH}_2 \cdot \text{CHBr} \cdot \text{CO} \cdot \text{NCS}$, by combination with aniline, yielded *ethylphenylthiohydantoïn*,



White needles, m. p. 148—149° (corr.).

Ethylorthotolylthiohydantoïn.—A sandy, white powder, melting at 95—96°, to a turbid liquid, clearing at 98°; the *hydrochloride* forms white needles, m. p. 224—225° (corr.). When boiled with alkali, then acidified and mixed with ferric chloride, followed by ammonia, a purplish coloration is produced, due, probably, to the presence of *α*-thiobutyric acid.

For greater convenience and precision in naming ‘thiohydantoïns’ of the above types, and the corresponding derivatives of $\text{CS} < \begin{smallmatrix} \text{NH} \cdot \text{CH}_2 \\ | \\ \text{NH} \cdot \text{CO} \end{smallmatrix}$, together with the related ‘thiohydantoïc’ acids, the author proposes a modification of the nomenclature at present employed.

6. “The amyl (secondary butyl-methyl) derivatives of glyceric, diacetylglyceric, and dibenzoylglyceric acids, active and inactive.”
By Percy Frankland, Ph.D., B.Sc., F.R.S., and Thomas Slater Price, B.Sc.

The authors describe the preparation and properties of amyl (lævo-active) glycerate (dextro-active), amyl (inactive) glycerate (dextro-active), amyl (lævo-active) glycerate (inactive), as well as of the corresponding diacetyl and dibenzoylglycerates. The interest attaching to these bodies depends, firstly, on those compounds with the inactive amyl and active acid radicle filling gaps in the series of active glycerates, diacetylglycerates, and dibenzoylglycerates already prepared, and described by one of the authors. The position of the maximum rotation in these series becomes thus more precisely localised. Secondly, the influence of one asymmetric carbon atom on another in the same molecule can be ascertained, and the principle of the superposition of the optical effects of the asymmetric carbon atoms is put to the test and found to hold good. Thus the authors show how the optical properties of the eight possible active amylglycerates can be calculated from a knowledge of the optical properties of two particular ones, and similarly in the case of the eight active amyl diacetylglycerates, and the eight active amyl dibenzoylglycerates.

In the series of the dibenzoylglycerates, of which now the methyl

ethyl, propyl, and amyl terms are known, the rotation diminishes from the methyl to the amyl compound, and there is every probability that in this series the rotation will be found to pass through a minimum.

The influence of temperature on the rotation of all the compounds described has been also investigated, with the result that, as before, the rotation of the glycerates was found to be but little sensitive to temperature, the rotation of the diacetylgycerates much more sensitive, and that of the dibenzoylgycerates still more sensitive to temperature. Again, as before, it was found that the negative rotation of the diacetylgycerates increased, whilst the positive rotation of the dibenzoylgycerates diminished with rise of temperature. It was, however, further found that the compounds in which the amyl alone was active, viz., amyl (lævo-active) glycerate (inactive), amyl (lævo-active) diacetylgycerate (inactive), and amyl (lævo-active) dibenzoylgycerate (inactive) had their rotation practically unaffected by temperature, the sensitiveness to temperature being thus confined to the rotation dependent on the asymmetric carbon atom belonging to the glyceric acid part of the molecule.

7. "The refraction constants of crystallised salts." By Alfred E. Tutton.

This communication is a reply to certain criticisms of Pope (Trans., 1896, 69, 1530) concerning the author's work on the refraction constants of the sulphates and double sulphates containing potassium, rubidium, and cæsium (Trans., 1896, 69, 502). It is first shown that the claim of Pope to originality, in showing that the molecular refractions of solid salts are the sums of the atomic or equivalent refractions of the components, is unfounded, and that the whole of the conclusions published in the author's memoir, with regard to this subject, in connection with the entire twenty-two double sulphates investigated, were based upon the assumption of this rule. The second point is with regard to the criticism that the mean molecular refractions of the salts given were not the mean of the three values corresponding to all three refractive indices of the biaxial crystals in each case, but the mean of the two extreme values; and with regard to the recalculated results presented by Pope taking the intermediate value into account, which Pope appears to show exhibit far greater accordance than the author's values. The author points out that the course pursued was taken after careful consideration, with full knowledge of the problem, and for the sufficient reason that the whole of the salts in question were so extremely feebly doubly refractive, and the extreme values consequently so close together, that he judged that the difference between the results of the two processes would be within the range of

experimental error. He then shows that grave errors occur in Pope's recalculations; there are numerous errors in table III, two of them being whole numbers, one of which amounts to a fifth of the total value, and table IV is entirely wrong in consequence. When the errors are corrected, the latter table, in which the two whole-number errors also appear, assumes quite a different aspect, the results of the two modes of calculation become nearly identical, the differences between them being then well within the range of the experimental error, and amply justify the author's course. The author finally shows that the two cases, rubidium sulphate and caesium sulphate, quoted by Pope as adverse to the author's statement that "the matter in a crystal has, for refraction purposes, the same average effect as the same matter uncrystallised," lead to diametrically opposite conclusions; and, moreover, that such conclusions are of no value, as the differences in question between the values for solution and for the crystallised condition are well within the range of experimental error.

8. "The refraction constants of crystalline salts: A Correction." By William Jackson Pope.

The author regrets to find, notwithstanding that the numbers used in his paper (*Trans.*, 1896, 69, 1530) were several times checked, an error of a unit in two numbers in table III which vitiates the first line of table IV (*loc. cit.*, p. 1537); the first, third, seventh, and ninth numbers in the line in question should be 5.11, 5.26, 14.5, and 15.00, and in the fourth column of table III the numbers 4.25 and 13.51 should each be increased by unity. The comparison made in the six lines following table IV is consequently unjustifiable.

The error, although to be regretted, in no way affects the general argument, but, if left uncorrected, tells unfairly against the method of calculation used by Tutton.

9. "On the wide dissemination of some of the rarer elements and the mode of their association in common ores and minerals." By W. N. Hartley, F.R.S., and Hugh Ramage.

By means of spectrographic analysis the authors have examined about 170 specimens of ores and minerals, comprising oxides, carbonates, and sulphides. Half a gram of each substance, finely powdered, was heated in the oxyhydrogen flame. The following elements and their compounds yield spectra under these conditions which are easily observed.

(a) In very small quantity—

Na, Ca, Pb, Ni, K, Se, Bi, Cu, Ba, Cr, Rb, Ga, Mn, Ag, In, Fe, Cs, Tl, Co.

(b) In small quantity—

Li, Au, Cd, Sb, and Sn.

(c) In such quantity as to indicate that the substance is a principal constituent of the mineral—

Be, B, Di, Te, Rh?, Mg, Al, S, Pd?, Zn, Ce, Se, Ru?

Some of the metallic elements in the list (c) under special conditions yield oxyhydrogen flame spectra, which are easily observed even in small quantity. Other elements than the above have not been sought for in this research.

In almost every case the locality from which the specimens of ores and minerals came is recorded, and the results of the spectrographic analysis have been tabulated. Several novel and interesting facts are disclosed, which may be stated very briefly as follows.

Clay iron-stones and black-band ores.—Fifty-one specimens examined. All contain sodium, potassium, copper, calcium, and manganese; 47 contain silver; 32, lead; 21, gallium; 13, nickel; 12, chromium; 1, strontium; and 1, thallium. Probably all contain rubidium, but it is difficult to recognise owing to the multitude of iron lines. Three specimens undoubtedly contain it.

Brown hæmatites.—Six specimens examined. All contain sodium, potassium, copper, calcium, and manganese; 5 contain silver; 5, lead; and 5, nickel; 3, chromium; 2, gallium; 2, thallium; and 1, indium. Probably all contain rubidium; in one it is undoubtedly present.

Limonites.—Five specimens examined. All contain sodium, potassium, silver, manganese, and apparently rubidium; 4 contain calcium; 4, lead; 3, copper; 3, nickel; 1, gallium; 1, thallium; and 1, chromium.

Red hæmatites.—Eighteen specimens examined. All contain sodium and potassium; 17 contain copper; 14, manganese; 13, silver; 12, lead; 12, calcium; 3 contain gallium; 3, indium; 3, nickel; 2, chromium; 1, rubidium; and 1, thallium.

Magnetites.—Seven specimens examined. All contain sodium, potassium, copper, silver, calcium, gallium, lead, and manganese. Four appear to contain rubidium; 2, nickel; and 1 contains indium.

Siderites.—Five specimens examined. All contain sodium, potassium, copper, silver, calcium, indium and manganese; 3 contain lead; 1 contains rubidium; 1, gallium; 1, cobalt; 1, nickel; and 1 bismuth.

Aluminous minerals, such as bauxites.—Seventeen specimens. All contain sodium, potassium, copper, calcium, and iron; 16 contain gallium; 15, chromium; 13, nickel; 12, manganese; 9, silver; 3, lead, and 2, rubidium.

Manganese ores and minerals.—Eleven specimens examined. All contain sodium, potassium, copper, calcium, and iron; 10 contain silver; 5, rubidium; and 5, nickel; 4, gallium; 4, lead; and 4, strontium; 2, barium; 1, indium; and 1, cobalt.

Blendes.—Fourteen specimens examined. All contain sodium, copper, silver, and iron ; 13, potassium ; 12, gallium ; 12, lead ; 10, silver ; 10, manganese ; 9, indium ; 7, cadmium ; 4, thallium ; 2, nickel ; and 1, chromium. The zinc was observed in only 8 specimens, the spectrum being hidden by other lines.

Nickel and Cobalt ores.—Nine specimens examined. All contain sodium, potassium, copper, calcium, iron, and nickel ; 6 contain cobalt ; 6, lead ; 4, chromium ; 3, silver ; 1, barium ; and 1, strontium.

Tin ores.—Five specimens examined. All contain sodium, indium, and iron ; 4 contain potassium ; 3, copper ; 3, calcium ; 3, lead ; 2, silver ; and 2, manganese.

Galenas.—Eight specimens. All contain sodium, potassium, copper, silver, and iron ; 4 contain manganese ; and 3, calcium.

Pyrites.—Thirteen specimens. All contain sodium, potassium, copper, silver, calcium, and iron ; 11 contain lead ; 10, manganese ; 5, indium ; 5, thallium ; 5, nickel ; and 1, gallium.

Out of 168 ores and minerals examined, gallium occurs in 68 ; indium in 30 ; and thallium in 17. Rubidium occurs probably in 70, but unquestionably in 13. All the carbonates of iron and all the tin ores, without exception, contain indium. With one single exception, all the bauxites contain gallium.

Silver, copper, calcium, potassium, and sodium are very widely disseminated through all ores and minerals.

The authors draw deductions as to the formation of beds and lodes of ore from the following facts, which they claim to have established. First, that certain groups of ores and minerals are pervaded by small quantities of the same metals as common impurities. Secondly, the rare metals, more particularly rubidium, gallium, indium, and thallium, are associated with the same groups of minerals, and also with allied groups.

It is easy to trace the association of similarly constituted compounds to their connection with elements related to each other, as determined by the periodic system of classification. These compounds have certain properties in common, distinctive of the groups of elements and compounds to which they belong ; hence in a given course of chemical changes, similar compounds are formed and thrown together by precipitation or otherwise. All the minerals mentioned have undoubtedly had an aqueous origin.

The presence of the alkali metals in all the specimens, but in variable proportions, has a special significance.

In the analysis of many different precipitates, obtained both in neutral and even strongly acid solutions, the alkali metals have been found in combination with the precipitated substance. It has long been known that manganese, aluminium, and iron in the state of hydroxides, combine with more or less of the alkalis, but in a great measure such combinations have been disregarded.

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ANNIVERSARY MEETING.

The Anniversary Meeting will be held on Wednesday, March 31st, at 3 o'clock in the afternoon.

ANNIVERSARY DINNER.

It has been arranged that the Fellows of the Society and their friends shall dine together at the Criterion Restaurant on Wednesday, March 31st, at 6.30 for 7 p.m.

At the next meeting, on Thursday, February 4th, the following papers will be received. The authors of those marked with an asterisk have signified their intention of being present.

* "The Oxidation of Nitrogen." By Lord Rayleigh.

* "An Improved Apparatus for Steam Distillation." By F. E. Matthews, Ph.D.

* "Researches in the Stilbene Series I." By J. J. Sudborough, Ph.D.

* "Di-ortho Substituted Benzoic Acids III. Hydrolysis of Substituted Benzamides." By J. J. Sudborough, Ph.D., P. G. Jackson and L. L. Lloyd.

PROCEEDINGS

OF THE

CHEMICAL SOCIETY.

EDITED BY THE SECRETARIES.

No. 174.

Session 1896-7.

February 4th, 1897. Mr. A. G. Vernon Harcourt, President, in the Chair.

Mr. H. L. Bowman was formally admitted a Fellow of the Society.

Certificates were read for the first time in favour of Messrs. John Owen Alexander, 11, Avenue Road, South Norwood Park, S.E.; John B. Ashworth, 16, Ducie Street, Prince's Park, Liverpool; John Barclay, B.Sc., Avenue Cottage, near Bromsgrove, Worcestershire; Frank Bastow, B.Sc., 1, Braithwaite, Keighley; William Dillon, 7, Laurel Place, Chapel Lane, Armley, Lancashire; E. G. Guest, M.A., The Grammar School, Kirkham, Lancashire; T. Hartley, Gatwell Street, Bruton, Somerset; John Holmes, Crewe Villa, Putney Bridge Road, S.W.; O. C. Johnson, 52, Thayer Street, Ann Arbor, Michigan, U.S.A.; H. King, B.Sc., 4, North Street, Scarborough; H. M. Lloyd, 28, Victoria Street, Merthyr; R. N. Lyne, Government Offices, Zanzibar; C. H. Parker, Manor House, Tettenhall, Wolverhampton; S. Pollitt, B.Sc., 19, Paulton Square, Chelsea, S.W.; M. Wilderman, Ph.D., Davy Faraday Laboratory, Albemarle Street, W.

Of the following Papers, those marked * were read.

*10. "Observations upon the oxidation of nitrogen gas." By Lord Rayleigh, F.R.S.

On the basis of Davy's assertion that the dissolved nitrogen of water is oxidised during electrolysis, various attempts were made; but they led to no useful result, even leaving it doubtful whether Davy's facts are correct.

The influence of pressure upon the oxidation of nitrogen by the electric flame was next examined. It appeared that, while in a small vessel the effect of increased pressure was favourable, but little advantage resulted when the vessel was large enough to give the maximum of the effect. The results are as follows:

effect at a given pressure. The pressures compared were two atmospheres, one atmosphere, and half an atmosphere.

The remainder of the paper is devoted to a detailed description of a large scale apparatus (shown working) in which 21 litres of mixed gases enter into combination per hour, at an expenditure of about 1 horsepower.

DISCUSSION.

PROFESSOR ARMSTRONG, referring to Lord Rayleigh's remark as to the importance of the platinum electrodes being red-hot, enquired whether there was any evidence that the platinum played a special part in the process.

PROFESSOR RAMSAY suggested, as an explanation of the better results obtained when a large vessel was employed, that nitric oxide was the first product, and that this subsequently combined with oxygen to form the peroxide.

THE PRESIDENT considered it probable that some of the oxide of nitrogen first formed was subsequently decomposed by the heat of the flame itself, and that the large vessel, by presenting a large surface of alkaline liquid, favoured the rapid absorption of the oxide of nitrogen, and thus less was decomposed than would be the case in a smaller vessel, where the rate of absorption was smaller. He enquired with what proportion of nitrogen to oxygen combustion occurred most rapidly.

PROFESSOR M'LEOD remarked that he had made an experiment in the manner originally suggested by Cavendish, and had found that nitrite as well as nitrate was formed.

LORD RAYLEIGH, in reply, said that the larger vessel apparently led to better results by increasing the facilities for absorption. He did not consider that the platinum played any special part in the process. The action seemed most rapid when the proportion of air to oxygen was as about 5 to 6, which corresponds with two of nitrogen to three of oxygen. He believed that both nitrite and nitrate were formed. The apparatus shown was suitable for the preliminary concentration, but not for the final purification of argon.

*11. "On some apparatus for steam-distillation." By F. E. Matthews, Ph.D.

In this paper several forms of apparatus for automatically steam-distilling substances are described.

Some solids of high melting point may be separated by boiling the substance mixed with water in a flask fitted with a reflux condenser, the solid substance adheres to the inside of the condenser, whence it can be removed from time to time.

For liquids heavier than water, the flask in which the mixture is

boiled is connected with the side tube of an ordinary distilling-flask; this distilling-flask, filled with water up to the side-tube, serves as the receiver. Into the neck of the receiver and passing below the surface of the water, a bent Liebig's condenser is fitted which has the peculiarity of having a hole made in it a short distance above the level of the water in the receiver. On boiling the mixture in the flask, the vapours pass up the side-tube of the receiver into the upper portion of its neck and thence through the hole into the receiver when condensation takes place. The condensed liquids run down the condenser to the water-level in the receiver, where a drop of the heavy fluid sufficiently large to sink is formed from time to time. The condensed liquids displace their own volume of water, which flows from the receiver through the side tube back again to the boiling-flask. In all cases in which vapour is passing in one direction in a tube, and water in the other, the advantage of perforating the tube near its lower end is pointed out.

For liquids lighter than water, the apparatus consists of the boiling-flask, which is an ordinary distilling flask; this is connected by the upper opening to an upright tube furnished with a T-piece. The top of the upright tube is connected to the condenser, the lower end dips two or three inches into a Woulfe's bottle, containing water in sufficient quantity, which serves as the receiver. Through another neck of the Woulfe's bottle, a second tube passes from the bottom of the bottle and is connected to the side-tube of the boiling-flask. The mixed vapours pass from the boiling-flask into the upright T-tube, thence into the condenser; there becoming condensed, they fall down into the T-tube, producing a column of liquid which forces water from the bottom of the receiver back into the boiling-flask through its side-tube.

A modification of this apparatus dispenses with the necessity of having an india-rubber connection exposed to the hot vapour. In this modification the boiling flask is an ordinary plain flask. This is connected to the condenser by a side-tube blown on to the upright tube. The water returns to the boiling-flask through another T-tube, blown on to the side-tube of the upright tube. For conveniently emptying the receiver without dismantling the apparatus, a separating-funnel with two necks may replace the Woulfe's bottle of the previous apparatus.

Many liquids bump badly when boiled with water; this can generally be got over by introducing a zinc platinum couple into the boiling-flask. The temperature of the water in the boiling-flask may be raised by dissolving suitable substances such as sulphuric acid or calcic chloride in it, or liquids of higher boiling point may be used.

***12. "Researches in the Stilbene Series. I." By John J. Sudborough, Ph.D.**

The author has obtained benzil as one of the products of the action of zinc dust and acetic acid on benzoïn; if the action is con-

tinned the benzil disappears and the chief product is deoxybenzoïn. The formation of an oxidation product of benzoïn by the action on it of zinc dust and acetic acid appeared so remarkable that the author has studied the action of acetic acid alone on benzoïn, and he finds that small quantities of benzil are formed if benzoïn is heated with six times its weight of glacial acetic acid on the water bath for eight—nine hours.

By the action of phosphorus pentachloride on deoxybenzoïn a solid chlorstilbene has been obtained, which differs from Zinin's oily compound. It melts at 45° , yields a dibromide and a dichloride, also with nitrous fumes two compounds probably represented by the formulæ $\text{Ph} \cdot \text{CHNO}_2 \cdot \text{C}(\text{ClNO}_2) \cdot \text{Ph}$ (m. p. 128°) and $\text{Ph} \cdot \text{C}(\text{NO}_2) : \text{C}(\text{NO}_2) \cdot \text{Ph}$ (yellow prisms m. p. $104-105^{\circ}$).

An oily compound can be obtained by the action of phosphorus pentachloride on deoxybenzoïn at low temperatures. The oil contains the same amount of chlorine as solid chlorstilbene.

Methyldeoxybenzoïn and ethyldeoxybenzoïn on treatment with phosphorus pentachloride can be made to yield both oily and crystalline compounds, analysis of which points to their being methyl- and ethyl-chlorstilbenes. Solid methylechlorstilbene melts at 124° , and the corresponding ethyl compound at 60° . The dichlorides and dibromides are also described. The question as to the nature of the oily compounds has not been settled; the author describes a method by which he proposes to determine whether they are merely slightly impure forms of the solid compound, true stereo-isomerides, or structurally isomeric with the solid compounds.

***13. "Diortho-substituted benzoic acids. III. Hydrolysis of substituted benzamides."** By John J. Sudborough, Ph.D., Percy G. Jackson, and Lorenzo L. Lloyd.

In order to determine whether diortho-substituted benzamides exhibit the same remarkable degree of stability towards hydrolysing agents as characterises the diortho-benzoyl chlorides (Trans., 1895, 67, 587) and ethereal salts, the authors have investigated the following compounds.

Ortho-, meta-, and para-brombenzamide; 2:4-, 2:6- and 3:5-dibrombenzamide; 2:4:6- and 3:4:5-tribrombenzamide; 2:4:6-trichlorbenzamide; 2:4:6-trimethylbenzamide (mesitylformamide) and mesitylacetamide, $\text{C}_6\text{H}_2\text{Me}_3 \cdot \text{CH}_2 \cdot \text{CONH}_2$. Of the three mono-substituted brombenzamides the ortho-compound proves to be somewhat more stable in the presence of boiling (30 per cent.) sulphuric acid than the meta- and para-compounds. This agrees with the properties of the corresponding methylic monobrombenzoates and of the monobrombenzoyl chlorides.

Of the three dibromamides the 2:6- or di-ortho-substituted compound proves to be the one most difficult to hydrolyse by means of

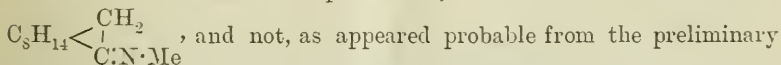
75 per cent. sulphuric acid, and again of the two tribromamides the 2:4:6- or symmetrically substituted amide is much more stable than the isomeric 3:4:5-tribrombenzamide. 2:4:6-trichlorbenzamide although not hydrolysed so readily as 2:4- and 3:5-dibrom- and 3:4:5-tribrombenzamide is less stable than the corresponding 2:4:6-tribrom-compound.

The methyl derivatives could not be investigated as regards their hydrolysis with 75 per cent. sulphuric acid, as they are charred and decomposed by this means. Towards 30 per cent. sulphuric acid, the mesitylformamide is much more stable than the corresponding acetamide.

In the course of this investigation the following new compounds have been obtained:—3:5-Dibrombenzamide, m. p. 187°; 2:4:6-tribrombenzonitrile, m. p. 127°; 2:4:6-tribrombenzamide m. p. 193—194°; 3:4:5-tribrombenzamide, m. p. 199°; 2:4:6-trichlorbenzonitrile, m. p. 75°; 2:4:6-trichlorbenzamide, m. p. 177°; mesitylformamide, m. p. 105°; mesitylacetamide, m. p. 210°.

***14. "Conversion of camphoroxime into methylcamphorimine and camphenylnitramine." By M. O. Forster, Ph.D.**

Further investigation of the base obtained on heating camphoroxime in sealed tubes with methylic iodide has proved it to be the methyl-derivative of Tiemann's camphorimine; it therefore has the formula



examination (Proc., 1895, 11, 145), the formula, $\text{C}_{12}\text{H}_{10}\text{N}$. This is shown by its behaviour towards concentrated hydrochloric acid at 200°, giving rise to camphor and methylamine.

Methylcamphorimine hydrochloride and *methiodide* melt at 270° and 231—232°, respectively; the *perbromide* has also been prepared.

The action of dilute nitric acid on camphoroxime, if interrupted after a few minutes, gives rise to *camphenylnitramine*, which is also formed when a solution of the oxime in chloroform is treated with nitrogen peroxide.

An acid solution of potassium permanganate converts camphoroxime into an unstable nitroso-derivative, which separates from the liquid as a sticky, green mass; when preserved in the desiccator the substance deliquesces, and loses its green colour, the yellow residue yielding camphor when distilled in an atmosphere of steam.

15. "Note on Wechsler's method for the separation of fatty acids." By Arthur W. Crossley.

Wechsler (*Monatsh.*, 1893, 14, 462) has described a method for the separation of fatty acids, the principle of which method is contained in the following statement.

If to a mixture of two fatty acids four-fifths of the caustic soda necessary to neutralise them be added, and the whole steam-distilled, the distillate contains the pure higher-boiling acid. From the residue of the distillation a further three-fifths of the acids are set free by addition of sulphuric acid, and the whole distilled in steam. Finally, the remaining fifth of the acids is set free, and in this case the distillate contains the lower boiling acid in a pure condition.

The purity of the acids contained in the various distillates was proved by converting them into silver salts and subsequent analysis of these salts.

After trying this method of separation, with very unsatisfactory results, on a mixture of fatty acids obtained in a research on which Professor Perkin and the author have been engaged for some time past, it was thought advisable to test some of Wechsler's experimental data.

Accordingly, Wechsler's experiments have been carefully repeated and results obtained which do not agree with that author's.

As Wechsler always worked with equimolecular proportions of fatty acids, the result of some experiments are recorded in which varying proportions of fatty acids were employed. In every case, the results were unsatisfactory, for even when using three molecules of the lower to one of the higher boiling acid, the former was not obtained pure in the last distillate, and the first distillate contained a decided mixture of the two acids.

It is therefore to be concluded that Wechsler's method does not give such good results as its author suggests, nor can it in any way be looked upon as a satisfactory method for separating mixtures of fatty acids.

16. "On the crystalline structure of gold and platinum nuggets and gold ingots." By A. Liversidge, LL.D., F.R.S.

In view of the theory that gold nuggets are built up of concentric layers deposited round a central nucleus, the author has examined a large number of specimens from various sources. The nuggets were ground down, or sliced through, to obtain sections, which were polished and etched by suitable solvents. They all possess a well-marked crystalline structure, and usually enclose foreign substances. The crystalline structure is not incompatible with an aqueous origin; and the author suggests that the gold has been slowly deposited from solution, either at ordinary or at high temperatures: the nuggets being more or less rolled masses of gold which have been set free from disintegrated veins.

17. "On the presence of gold in natural saline deposits and marine plants." By A. Liversidge, LL.D., F.R.S.

The author gives a preliminary account of the results of the examination for gold of rock salt, sylvine, and other similar saline

deposits, bittern, sea-weed, kelp, oyster shells, &c. The process of determination used was to add from 0.5 to 5 grains of ferrous sulphate to the unfiltered solution of 100 to 1000 grams of the salt in water. The resulting precipitate was then scorified with lead and cupelled. The natural salts contained from 1 to 2 grains of gold per ton, whilst kelp and bittern furnished in some cases as much as from 14 to 20 grains.

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Berthelot, M. *Science et Morale*. Pp. xii+518. Paris 1897.

Hoff, J. H. van't. *Vorlesungen über Bildung und Spaltung von Doppelsalzen*. Pp. iv+95. Mit 54 figuren im Text. Leipzig 1897.

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From Prof. S. Cannizzaro.

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From S. G. Rosenblum.

Pamphlets.

British Association for the Advancement of Science. Toronto Meeting, 1897. *Preliminary Programme, with Maps and Illustrations*. Toronto 1896.

From the Association.

RESEARCH FUND.

Mr. J. J. Tustin has made a donation of One Thousand Guineas to the Research Fund of the Society.

PASTEUR MEMORIAL LECTURE.

The Pasteur Memorial Lecture will be delivered by Professor Percy Frankland, Ph.D., F.R.S., at an extra meeting of the Society on Thursday, March 25th, at 8 p.m.

ANNIVERSARY MEETING.

The Anniversary Meeting will be held on Wednesday, March 31st, at 3 o'clock in the afternoon.

ANNIVERSARY DINNER.

It has been arranged that the Fellows of the Society and their friends shall dine together at the Criterion Restaurant on Wednesday, March 31st, at 7 p.m.

At the next meeting, on February 18th, the following papers will be received. The authors of those marked with an asterisk have announced their intention of being present.

* "The oxidation of sulphurous acid by potassium permanganate." By T. S. Dymond and F. Hughes.

"Sodamide, and some of its substitution derivatives." By A. W. Titherley, M.Sc., Ph.D.

"Rubidamide." By A. W. Titherley, M.Sc., Ph.D.

"Dissociation pressure of alkyl ammonium hydrosulphides." By J. Walker, D.Sc., and J. S. Lumsden, Ph.D.

"On the spectrographic analysis of some commercial samples of metals, of chemical preparations and minerals from the Stassfurth potash beds." By W. N. Hartley, F.R.S., and H. Ramage.

"Supposed condensation of benzil with ethyl alcohol: A correction." By F. R. Japp, LL.D., F.R.S.

* "The viscosity of mixtures of miscible liquids." By T. E. Thorpe, LL.D., F.R.S., and J. W. Rodger.

CERTIFICATES OF CANDIDATES FOR ELECTION AT THE NEXT BALLOT.

N.B.—The names of those who sign from “General Knowledge” are printed in *italics*.

The following Candidates will be balloted for on March 4th.

Alexander, John Owen,

11, Avenue Road, South Norwood Park, S.E.

Analytical Chemist. Six years Assistant to the late Dr. Wallace, Glasgow. Six years Chemist in Demerara. Have done special Sugar reporting work in Louisiana, Brazil, France, Belgium, Germany, French West Indies, Antigua. Now managing Messrs. Cannon & Newton's Analytical Laboratory, 39, Mincing Lane, E.C.

Frank L. Teed.

B. E. R. Newlands.

D. A. Louis.

John A. R. Newlands.

William Newton.

Arbuckle, William,

34, Moore Street, Cadogan Square, S.W.

Assistant in the Davy-Faraday Research Laboratory of the Royal Institution. Four years Assistant in the Chemical Laboratory of the Heriot-Watt College, Edinburgh, under Professors W. H. Perkin, jun., and J. Gibson. Eighteen months as Student in R. R. Tatlock's (City Analyst) Laboratory, Glasgow.

W. H. Perkin, jun.

James Dewar.

Alexander Scott.

Robert. N. Lennox.

John W. Heath.

Ashworth, John B.,

16, Ducie Street, Prince's Park, Liverpool.

Analytical Chemist. Assistant for 8 years to Mr. Alfred Smetham. Conducted, conjointly with Mr. Smetham, investigations into the Chemistry of Cheshire Cheese-making on behalf of the Board of Agriculture.

Alfred Smetham.

Bernard Dyer.

J. Augustus Voelcker.

Charles S. Cassal.

Otto Helmer.

Barclay, John,

Avenue Cottage, near Bromsgrove, Worcestershire.

Member of firm of Southall Bros. and Barclay, Birmingham, Manufacturing Chemists. (1888) B.Sc., London University, 3rd Class Honours in Chemistry. Four years Lecturer in Materia Medica at Mason College. Associate of Mason College. Pharmaceutical Chemist. Writer of several papers (Materia Medica, Pharmaceutical Chemistry), published in *Pharmaceutical Journal* Author of 5th edition, Southall's Materia Medica, 1896.

William A. Tilden.

John Attfield.

Thomas Turner.

W. W. J. Nicol.

J. J. Sudborough.

Arthur J. Cooper.

Bastow, Frank,

1, Braithwaite, Keighley, Yorkshire.

Head-Master, Science Department of the Technical Schools, Salt Schools, Shipley. For four years a Student at the Royal College of Science, South Kensington, attending the courses in Chemistry, Physics, Botany, Biology, Geology, and Mechanics. Bachelor of Science and Bachelor of Arts, London University. For ten years past a Teacher of Theoretical and Practical Chemistry, having prepared students for all stages of the Science and Art Department's Examinations.

James Spencer.

Thomas J. Roberts.

George W. Slatter.

Thorp Whitaker.

Walter M. Gardner.

C. Rawson.

A. Rée.

Brown, James Herbert,

Dallas Place, Lancaster.

Assistant Manager at the Corporation Gas Works, Lancaster. Educated at the Dewsbury Wheelwright Grammar School under A. E. Holme, Esq., M.A. (Oxon.). Obtained a Two Years' Akeroyd Science Scholarship to the Yorkshire College, Leeds. Studied Chemistry under Professor Smithells and Mr. Ingle. After which I was employed by J. Brown & Co., Manufacturing Chemists, Dewsbury, as Public Analyst, and am at present Assistant Manager to Charles Armitage, Esq., A.M.I.C.E., Engineer and Manager at the Corporation Gas Works, Lancaster.

Chas. Armitage.

A. E. Holme.

Arthur Smithells.

Herbert Ingle.

Joseph Brown.

R. L. Barnes.

Cartmell, Alfred,

Alexandra Road, and The Laboratory, Burton-on-Trent.

Analytical Chemist and Consulting Brewer. Analyst to the Tutbury and Repton Rural District Council. Ten years Chemical Assistant

to the late Rowlandson Cartmell, F.C.S., and also Successor to since 1888.

Adrian J. Brown.

Walter Odling.

C. O'Sullivan.

G. Harris Morris.

Horace T. Brown.

William W. Butler.

John Spiller.

Chikashigé, Masumi,

Kumamoto, Japan.

Professor of Chemistry. B.Sc., Imperial University, Japan. Five years as Student of Chemistry in the Laboratories of the University. Author of papers on "Mercury Perchlorates" and "The Atomic Weight of Japanese Tellurium" in the *Chemical Society's Journal*; and of two notes in the *Chemical News*.

Edward Divers.

Jōji Sakurai.

Toyokichi Takamatsu.

Hikorokurō Yoshida.

Tanemasa Haga.

Michitada Kawakita.

Cholerton, Alfred Foster,

Lyndum House, Lincoln Street, Leicester.

Manufacturing Chemist. Engaged over 20 years in Manufacturing Chemistry with Practical Laboratory Work. Formerly Student at University College, Nottingham. Partner in the firm of A. de St. Dalmas & Co., Leicester.

Frank Clowes.

Geo. Ward.

Thomas Fairley.

S. F. Burford.

Lewis Ough.

J. J. Sulborough.

Godfrey Melland.

Creasey, Clarence Hamilton,

78, Baggeholme Road, Lincoln.

Lecturer on Chemistry and Physics, School of Science, Lincoln. Originally trained as an Engineer, spending five years at R. Howesly & Son's, Spittlegate Ironworks. Gave up Engineering for Chemistry, and spent two years at Royal College of Science, London, studying Chemistry and Physics 1894—6. Appointed to present post September, 1896. Desirous of keeping abreast of recent Chemical discoveries.

William A. Tilden.

W. Palmer Wynne.

M. O. Forster.

J. S. S. Brame.

A. E. Tutton.

Crowther, James,

West Field, Lightcliffe, Halifax.

Head-Master Technical School, Halifax. Two years Assistant Lecturer in Chemistry at the Manchester Technical School. Bachelor

of Science, London. Chemistry one of the subjects for Final Examination. Honours, Theory, Science and Art Department.

Gibson Dyson.

John Allan.

Jas. Grant.]

Ernest Bentz.

William L. Hiepe.

Davis, William Alfred,

108, Gordon Road, Peckham, S.E.

Chemist to Messrs. S. Courtauld & Co., Crape Manufacturers, Braintree, Essex. Associate of the City and Guilds Institute. Author of "3'-Bromo-betanaphthol" (jointly with Dr. Armstrong), and of "Derivatives of Nitro- β -naphthols," and "Morphotropic Relations of Betanaphthol Derivatives" (*Proceedings*, 1896, pp. 230—234).

Henry E. Armstrong.

F. Stanley Kipping.

W. Palmer Wynne.

William J. Pope.

Gerald T. Moody.

Diamond, William,

Pye Bridge, Alfreton.

Chemist, Pye Bridge Chemical Works, Derbyshire. Was Student, Chemical Laboratory University College, Nottingham, and now Assistant Manager under Kempson & Co., Chemical Works, Pye Bridge.

Frank Clowes.

J. Bernard Coleman.

R. Lloyd Whiteley.

J. J. Sudborough.

Godfrey Melland.

Dillon, William,

7, Laurel Place, Chapel Lane, Armley, Leeds.

Commercial Traveller. Evening Class Teacher in Leeds Technical School. Works Analyst. Eight years' training in Chemistry and other Sciences at the Leeds School of Science. Three years as Demonstrator. Lecturer on Oils and Fats at Leeds Technical School. Bronze Medallist and First Class Honours of City and Guilds of London Institute.

Thomas Fairley.

B. A. Burrell.

S. J. Harris.

F. W. Branson.

Geo. Ward.

Dodgson, John Wallis,

47, Hirwain Road, Aberdare, Glamorganshire.

Teacher of Science. For 4 years (1892—96) Demonstrator and Assistant Lecturer at University Extension College, Reading. B.Sc. London University (Chemistry, Physics, Pure Mathematics). At present Science Teacher, Aberdare Technical and Intermediate Schools. Joint author of paper, "Action of Strong Acids upon Metals when in

Contact with One Another," read before the Society by Mr. G. J. Burch, M.A., and published in the Society's *Proceedings*, May, 1894.

W. W. Fisher.

Walter Palmer, B.Sc.

J. E. Marsh.

J. A. Gardner.

V. H. Veley.

P. Elford.

Dufty, Lawrence,

33, Broomhall Place, Sheffield.

Analytical Chemist. Assistant Evening Demonstrator in Metallurgical Laboratory, Sheffield Technical School. Last 7 years Senior Chemist at the Continental Steel Works, Attercliffe. Four years evening Student in Chemistry and Metallurgy, Sheffield Technical School. Associate of the School and Mappin Medallist for Metallurgy, Hadfield Medallist for Research Work in connection with Metallurgy. Sheffield Society of Engineers and Metallurgists. Paper on "The Determination of Silicon and Tungsten in Tungsten Steels," published in the above Society's *Journal*.

B. W. Winder.

G. T. W. Newsholme.

Fredk. J. Merrils.

Chas. Bradshaw.

Thos. Andrews.

Edwards, William Buckland,

5, Garlinge Road, Brondesbury, N.W.

Student. Student for three years in the Chemistry Department of the Central Technical College, and have been engaged during the present year in Research Work under Dr. Armstrong. Published a note with Dr. Kipping on Dimethylketohexamethylene in the *Proceedings*, No. 169.

Henry E. Armstrong.

Gerald T. Moody.

F. Stanley Kipping.

William J. Pope.

R. Berncastle.

Gibbons, Joseph Lake,

West Carlton Street, Blyth.

Principal of the Higher Grade Schools, Blyth, Northumberland (3 years). Late Senior Science Assistant, Gateshead Higher Grade Schools (9 years). Formerly Student-demonstrator in Science, Carmarthen Training College for Schoolmasters. Trained, Certificated (first in 1st Division) Teacher. College Exhibitioner. Lecturer in Science (Chemistry, Physics, Mathematics). Passed Science and Art Department's advanced examinations in Chemistry and Physics. Passed Chemistry, Physics, Mathematics Branch Second Arts Examination of Royal Uni-

versity, Dublin. Takes personal charge of the Science Department of the Blyth Higher Grade and Organised Science Schools.

Duncan T. Richards.

William Fowler.

Charles Ranken.

P. Phillips Bedson.

C. H. Corbett.

Gilbody, Alexander William,

Owens College, Manchester.

M.Sc. Victoria University, Ph.D. Munich. Four years as Student in Owens College Laboratories. B.Sc. with Honours in Chemistry, 1890. Two years at the University of Munich, 1891—1893. From October, 1895, has been researching with Professor Perkin at Owens College. Author of "Ueber die Einwirkung von Chloral auf Messeler Pyridinbasen," *Berichte*, xxvi.

Harold B. Dixon.

W. H. Perkin, jun.

A. Harden.

G. H. Bailey.

Jocelyn F. Thorpe.

Bevan Lean.

E. Haworth.

Gough, Harold Walter,

73, Billing Road, Northampton.

Assistant Master, and Lecturer on Advanced Physiology and Botany, and Elementary Sound, Light, and Heat, at Northampton and County Technical School. Natural Sciences Tripos, Pt. I. Scholar of Derby School, and Exhibitioner of Emmanuel College, Cambridge. Four months in Mr. Archbutt's Laboratory at Derby. Science Master at Wolverly Grammar School; and also at King Edward VI. School, Chelmsford, with Chemistry Class under the Essex County Council.

R. Elliot Steel.

W. J. Sell.

H. J. H. Fenton.

L. Archbutt.

Thomas H. Easterfield.

Goulding, Ernest,

18, Mercers Road, Holloway, N.

Assistant Chemist, Scientific and Technical Department, Imperial Institute. Student in the School of the Pharmaceutical Society, 1892-93. Student in the Research Laboratory of the Pharmaceutical Society, 1893-96. Joint author with Professor W. R. Dunstan of the following:—"The Action of Methylic Iodide on Hydroxylamine" (*Proc. C.S.*, 1894, 138); "The Hydriodides of Hydroxylamine" (*J.C.S.* 1896, 839).

Wyndham R. Dunstan.

F. A. Abel.

Percy F. Frankland.

Herbert McLeod.

D. Hamilton Jackson.

Guest, Edward Graham,

The Grammar School, Kirkham, Lancashire.

Science Master at Kirkham Grammar School. M.A. Corpus Christi Collège, Cambridge. Intermediate B. Sc. London (Final in Chemistry and Geology, 1896.) Four years Science Teaching as Master at Ruthin School and Kirkham Grammar School.

Robert Irvine.

Alex. Crum Brown.

W. S. Anderson.

Frank T. Addyman.

Stevenson Macadam.

W. Ivison Macadam.

Harley, Vaughan,

25, Harley Street, W.

Professor of Pathological Chemistry, University College, London. M.D., M.R.C.P. "Chemical Changes of Sugar in Organism," *Proc. Roy Soc.* v., 54, 1893. "Sugar as a Food in the Production of Muscular Work," *Proc. Roy Soc.*, 1894. "The Chemical Pathology of Uric Acid," *Brit. Med. Journal*, 1895. "Absorption of Fat," *Journal of Physiol.*, 1895; "Beitrag zur Phys. des Blutzuckers," *Arch. J. d. ges. Phys.* 1895, &c.

William Ramsay.

John Shields.

G. Carey Foster.

Morris W. Travers.

Edward C. Cyril Baly.

Hartley, Ernald George Justinian,

Wheaton Aston Hall, Stafford.

B.A. (Oxon.). First Class Honours in Final Chemistry examination. Still studying Chemistry in Christ Church Laboratory.

A. Vernon Harcourt.

D. H. Nagel,

J. E. Marsh.

P. Elford.

Berkeley.

Hartley, Thos.,

Patwell Street, Bruton, Somerset.

Schoolmaster. Studied Chemistry as Brown Scholar at the Yorkshire College, Victoria University, in 1888—89—90, subsequently engaged in school teaching, and at present Science Master in Sexey's Trade School, Bruton (Organised Science School).

Arthur Smithells.

Charles H. Bothamley.

Alfred E. Tutton.

Wm. A. Knight.

Herbert Ingle.

Hy. Ellison, jr.

Heppenstall, Charles,

Ferrybank, Arklow, Co. Wicklow.

Manager of Messrs. Kynoch's Explosives and Chemical Works, Arklow. Three years Manager and Chemist, Fortis Powder Works. Four years Assistant Chemist, Brown Bayly's Steel Works. Honours,

Certificates, and Medals, City and Guilds of London Institute in Iron and Steel Manufacture, and Fuel.

W. H. Greenwood.

A. T. Cocking.

C. R. C. Tichborne.

Harry Carter Draper.

Jno. Northing.

J. Emerson Reynolds.

Ernest Scott.

Holmes, John,

Crewe Villa, Putney Bridge Road, S.W.

Assistant, Government Laboratory, Somerset House. Student for 8 years at Giggleswick. Last 4 years mainly devoted to Science subjects. One year in Laboratory of Jas. Baynes, Public Analyst, Hull. Two years' Chemical Training at the Royal College of Science, South Kensington.

T. E. Thorpe.

R. Bannister.

C. Proctor.

William A. Tilden.

Chapman Jones.

Ibbotson, Fred,

9, Melbourn Road, Spring Vale, Sheffield.

Lecturer on Chemistry, the Technical Schools, Sheffield. Associate Royal College of Science, Dublin. Bachelor of Science (1st Division) London University. Formerly Teacher of Chemistry at the Central Higher Schools, Sheffield, from 1889—1895; at present Lecturer in Chemistry at Sheffield Technical Schools and engaged on Organic Research during spare time.

W. N. Hartley.

L. T. O'Shea.

George Young.

W. Carleton Williams.

W. E. Adeney.

Hugh Ramage.

Innes, William Ross,

Mason College, Birmingham.

Demonstrator of Chemistry. B.Sc. of Victoria University (Honours, Chemistry), Ph.D. Heidelberg, A.I.C. Joint author with Professor Auwers of the paper entitled "Über das kryoskopische Verhalten substituierter Phenole in Naphtalin," *Zeitschr. für Phys. Chem.*, xviii., 4.

Percy F. Frankland.

C. F. Baker.

Walter G. McMillan.

John McCrae.

Charles A. Kohn.

Jerdan, David Smiles,

68, Union Street, Greenock.

Student. M.A., University of Glasgow, 1892. B.Sc., with First Class Honours in Chemistry, Victoria University, 1895. University Fellow in Chemistry of the Victoria University. Joint author of

papers published in the *Proceedings* of the Society on "The Direct Union of Carbon and Hydrogen." At present engaged in research under Prof. Victor Meyer, Heidelberg.

Harold B. Dixon.

W. H. Perkin, jr.

A. Harden.

G. H. Bailey.

Bevan Lean.

E. Haworth.

Johnson, Harold,

5, Boulevard Clovis, Bruxelles.

Analytical Chemist, engaged in the Laboratory of the *Petit Journal du Brasseur*, Bruxelles. Late Pupil of Mr. Sidney Harvey, Public Analyst. South Eastern Laboratory (General Analytical Chemistry). Late Pupil of Dr. Henri van Lauer, in General Chemistry, Analysis of Yeasts and Preparation of Pure ditto, Study of Ferments (Bacteria) and Enzymes, Member of the Belgian Chemical Society; have contributed papers on "L'acidité du moût," "L'analyse commerciale des glucoses." Have presented to the Belgian Brewers' Association a paper on "The Effect of Permanganate of Potash on Organic Contamination and Bacteria in Waters." Have obtained the First Class Honours Certificate in Brewing, London City and Guilds.

Sidney Harvey.

John Grove Johnson.

A. Boake.

G. Harris Morris.

C. O'Sullivan.

Johnson, Otis C.,

52, Thayer Street, Ann Arbor, Mich., U.S.A.

Professor of Applied Chemistry in the University of Michigan. Joint author of "Qualitative Chemical Analysis" (Prescott and Johnson's). Contributor of papers upon subjects in Analytical Chemistry.

Albert B. Prescott.

Thomas H. Norton.

John G. Spenser.

Bennett F. Davenport.

Joseph F. Geisler.

King, Herbert,

4, North Street, Scarborough.

Science Teacher. Studied at the Yorkshire College, Leeds. Bachelor of Science in the Honours School of Chemistry, Victoria University. Passed the examination for the Associateship of the Institute of Chemistry (July, 1896). Second Master of St. Martin's Grammar School, Lecturer in Chemistry under the Scarborough School Board.

Arthur Smithells.

Julius B. Cohen.

Herbert Ingle.

J. J. Hummel.

Henry R. Procter.

Lang, William Robert,

9, Crown Gardens, Glasgow, W.

Senior Assistant to Professor of Chemistry, University of Glasgow. B.Sc. (with special qualification in Chemistry), Glasgow. Has been an

Assistant here since 1889 and has had 7 years' experience as a Teacher of both Practical and Theoretical Chemistry, with Lectures, Tutorial Classes, and Laboratory instruction.

John Ferguson.

John Clark.

G. G. Henderson.

Stevenson Macadam.

W. Ivison Macadam.

J. T. Bottomley.

Edw. C. C. Stanford.

Lee, Theophilus Henry,

Hampden House, Phoenix Street, N.W.

Analytical Chemist and Assayer. Assistant Chemist in the employment of Messrs. Johnson, Matthey & Co., Limited, previously Assistant Chemist in the Netham Works of the United Alkali Co., Limited.

John S. Sellon.

G. Matthey, F.R.S.

Edward Matthey.

Ernest H. Cook.

Tho. Coomber.

F. R. Stephens.

Lloyd, Henry Morgan, F.R.M.S., A.P.S.

28, Victoria Street, Merthyr.

Chemist, Operative and Dispensing. Analytical work conducted chemically and microscopically. Operative Pharmaceutical Chemistry.

Robt. Hy. Owen.

H. S. Shorthouse.

A. W. Duncan.

F. Harwood Lescher.

M. Conroy.

W. A. H. Naylor.

Alfred Southall.

Lyne, Robert Nunez,

Government Offices, Zanzibar.

Resident Lecturer. Lecturer on Agriculture and Agricultural Chemistry. Lecturer under the Lincolnshire County Council. Late Student and Diploma of the Canterbury (New Zealand) Agricultural College.

John Wrightson, F.C.S.

William French, M.A., F.I.C.

Hudson Donaldson.

J. H. Gladstone.

John M. Thomson.

Martin, Charles Henry,

14, Aldred Street, Crescent, Salford.

Chemist and Assistant Manager Oil and Soap Works. My past and present work is Analytical and Manufacturing Chemistry.

George H. Hurst.

R. Stockdale.

G. W. Davies.

Charles Dreyfus.

David Watson.

North, Barker,

3, Manor Terrace, Felixstowe.

Army Science Tutor and Lecturer in Chemistry, Physics, and Geology. Author of a paper on "Gawalowski's Method of Estimating

Sulphuric Acid" (*Proc.*); joint author of a paper on "Diethyl Phosphorous Acid" (*Trans.*); joint author of "Introductory Lessons on Quantitative Analyses," and "Handbook of Quantitative Analysis."

T. E. Thorpe.

Percy F. Frankland.

A. E. Tutton.

George T. Holloway.

J. W. Rodger.

Parker, Charles Henry,

Manor House, Tettenhall, Wolverhampton.

Chemist. From 1886 I have been engaged—3 years in the Electrical and Chemical departments of Elwell-Parker, Limited, Wolverhampton; 1889—90, Student at Tettenhall College; 1890—1, Student at Owens College; 3 years in Chemical Laboratory at Electric Construction Company, Wolverhampton; and 18 months with Key Syndicate, Wednesfield, on Chemical, Electro-chemical, and other Research work.

E. W. T. Jones.

Chas. A. MacMunn.

Edward Bevan.

Harold B. Dixon.

G. H. Bailey

W. H. Perkin, jun.

Pollitt, Samuel, B.Sc.,

19, Paulton Square, Chelsea, S.W.

Science Master in the Brompton Higher Grade and Organised Science School, S.W. First Division Final B.Sc. Examination Victoria University; First Class Honours Practical (Inorganic), and Second Class Honours Practical Organic, Science and Art Department; 3 years Student at Owens College, Manchester; 2 years Chemistry Master, King's Lynn Technical School.

H. B. Dixon.

W. H. Perkin, jun.

G. H. Bailey.

E. Haworth.

W. H. Bentley.

Arthur Harden.

Bevan Lean.

Pullar, Herbert Spindler,

Rosebank, Perth, N.B.

Dyer. Student at Edinburgh University under Professor Crum Brown. Student at Yorkshire College, Leeds. Dyeing under Professor Hummel. Chemistry under Professor Smithells.

J. J. Hummel.

A. G. Perkin.

Arthur Smithells.

Rufus D. Pullar.

Geo. Ward.

Ralston, William,

337, Cathcart Road, Glasgow.

Chemist. B.Sc. (Lond.), A.I.C., Assistant to (late) Professor Dittmar, F.R.S. (L. & E.), LL.D., from 1886 to 1892. Assistant to Professor Henderson, M.A., D.Sc. F.I.C., from 1892 till the present.

G. G. Henderson.

A. Humboldt Sexton.

Thomas Gray.

Matthew A. Parker.

James Robson.

Edmund J. Mills.

Remington, John Stewart, M.R.A.C.,

Dromore, Milverton, Leamington.

Student. Formerly Student in Chemical Laboratory, Mason College of Science, Birmingham, from May, 1892, till July, 1894. Student and Member of the Royal Agricultural College, Cirencester, from September, 1894, to present time. Passed Honours, Diploma of Membership Christmas, 1896.

Edward Kinch.

Cecil Cooke Duncan.

Robt. Chas. Marchant.

William A. Tilden.

J. W. James.

Rosling, Edward,

Melbourne, Chelmsford.

Farmer and Landowner. Student of Royal College of Chemistry under the late Dr. Hofmann. Joint author with Dr. Bernard Dyer, of numerous reports on Field Experiments carried out for the Essex Agricultural Society. Interested chiefly in Agricultural Chemistry.

Bernard Dyer.

J. Augustus Voelcker.

Alfred Smetham.

John Spiller.

Charles E. Cassal.

Otto Helmer.

Southerden, Frank,

75, Barry Road, Dulwich, S.E.

Chemist to the Steel Brand Cement Factories. Have passed through the full Chemical course at Finsbury Technical College, and have the College Certificate. Worked for 8 months with Professor Meldola in his Research Laboratory on Constitution of Azo-compounds. For 3 years Chemist at Cement Works. An Associate of the Institute of Chemistry.

R. Meldola.

Geo. W. MacDonald.

E. S. Hanes.

M. O. Forster.

Julian L. Baker.

Stainer, William James, B.A., London,

3, Havelock Road, Stanford Avenue, Brighton.

Science Teacher (Chemistry and Mathematics principally). Author of *Synopsis of Advanced Chemistry* (published by Hughes & Co., 1s. 6d.)

Author of *Practical Chemistry Tables* (Stage E, South Kensington Syllabus). Second Master and Lecturer in Chemistry (up to Stage Advanced Theoretical and Practical, Inorganic, of South Kensington, Syllabus) to the Organised Science School (Brighton). Science Teacher to the Pupil Teacher Classes (Brighton) and to the Steyning (Sussex) Technical Education Committee (Sussex County Council).

William Briggs (M.A., LL.M.).	William Jago.
R. L. Taylor.	<i>Chapman Jones.</i>
<i>Henry R. Redman.</i>	<i>E. J. Cox.</i>

Stevens, Henry Potter,

14, Lower Sloane Street, Chelsea.

Student. B.A. (Oxon.). Scholar of St. John's College, Oxford. 1st Class Honours, School of Natural Science, 1896 (in Chemistry).

W. J. Russell.	F. D. Chattaway.
P. Elford.	W. W. Fisher.

A. Vernon Harcourt.

Sumner, Leonard,

Butt Hill, Prestwich, near Manchester.

Assistant Manager of the Broughton Copper Works, Manchester. London University Matriculation (Honours), 1887. Articled Pupil in the Engineering Works of W. Muir and Co. (Manchester), 1887-90. Student in Owens College, 1890-93. B.Sc. (Victoria—Honours, Engineering) and Associate of Owens College, 1893. Student City and Guilds Central Technical College, Session 1893-4, and obtained Certificate in Electricity and Chemistry. Worked for nine months in the Chemical Laboratory of the Broughton Copper Co., 1894-5. Studied Metallurgy, under Prof. Roberts Austen, at the Royal School of Mines, Session 1895-6, and passed the final examination in the First Class.

W. C. Roberts Austen	W. Gowland.
Henry C. Jenkins.	David Watson.

G. FitzBrown.

Thompson, Harry,

Walton House, West Parade, Anlaby Road, Hull.

Analyst. 1892-5, Winter Sessions, Science and Art Classes; Teacher, G. Carr Robinson, F.R.S.E., F.I.C., F.C.S. September, 1895, July, 1896, Assistant to Dr. A. Röhrig, 20, Linden St., Leipzig. 1896, April to July, Leipzig University, Chemical Study. July to October, II. Assistant, Königliche Landwirthschaftliche Versuchsstation, Rufach, Elsass-Loth. Direktor, Prof. D. M. Barth. November, Analyst to the Black Point Syndicate, Limited, in Milo, Greece.

G. Carr Robinson.	M. D. Penney.
Jas. Baynes.	John Caley.

Fred. E. Johnson.

Turnbull, Andrew,

Daldowie, Broomhouse, near Glasgow.

Private Research Assistant to Prof. P. F. Frankland. Student at Glasgow and West of Scotland College, 1890-3. Assistant in Chemical Dept., 1893-4. Student at Heidelberg University, 1894-6. Graduated at Heidelberg (Chemistry, Physics, and Botany), 1896. Research: "Ueber Benzolazo-tetrahydro- α -Naphthol und seine Derivate."

Percy F. Frankland.

Charles Frederic Baker.

Walter G. McMillan.

G. G. Henderson.

James Robson.

Matthew A. Parker.

A. Humboldt Sexton.

Turner, Basil William,

C/o Henry Turner, Collins Street, Annandale, Sydney, New South Wales.

Assayer and Metallurgist. Associate of the Royal School of Mines, London, in the division of Metallurgy. Have pursued a course of study in Theoretical and Practical Chemistry at the Sydney University, N.S.W., and also at the Royal College of Science, London.

Chapman Jones.

W. C. Roberts Austen.

Henry C. Jenkins.

William A. Tilden.

T. E. Thorpe.

A. Liversidge.

Walford, Samuel Matthew,

62, Bloom Street, Stockport,

Teacher of Chemistry. Chemistry Master at the Oldham Municipal and the Borough of Hyde Technical Schools. Science Master, Standard Grammar School. Have been similarly engaged about eight years. Studied Chemistry at Owens College, Manchester, and have attended courses in Chemistry and Metallurgy at the Royal College of Science, London. "Roscoe Exhibitioner" and "Chemistry Prizeman" of the Union of Lancashire and Cheshire Institutes. First Honours, Chemistry, Science and Art Department.

H. B. Dixon.

Bevan Lean.

G. H. Bailey.

W. H. Perkin, jun.

A. Harden.

Walker, James Wallace, MA., Ph.D.

Demonstrator in Chemistry, University College, London. Author and joint author with Professor Purdie of several papers which have appeared in the *Transactions* of the Chemical Society.

Thomas Purdie.

William Ramsay.

Morris W. Travers.

John Shields.

J. Norman Collie.

Sidney Williamson.

Wilderman, Meyer,

Davy-Faraday Laboratory, Albemarle Street, London.

Engaged in Scientific research in Physical Chemistry at present in the Davy-Faraday Laboratory at the Royal Institution. *Zeitschrift für Physikalische Chemie*, viii., ix., xi., xiv., xv., xv., xix., xix.; *Phil. Mag.*, July, 1895; *Transactions of the Chemical Society*, 1897, *Proceedings of the Royal Society*, 1896, *Berichte der Deutscher Chem. Ges.* 1890, 1891; *Journal für praktische Chemie*, &c.

A. Vernon Harcourt.

Wyndham R. Dunstan.

Herbert McLeod.

R. Meldola.

Robert Mond.

T. E. Thorpe.

The following Candidates are recommended by the Council under Bye-law I. (3).

Aquino, Thomas Hannibal,

Gadag, Dharwar District, India.

Assistant Surgeon, Bombay Medical Service. Licentiate of Medicine and Surgery, Bombay University. Late Teacher of Chemistry, Toxicology, and Materia Medica, Hyderabad Medical School, Sind. Member Indian Medical Association and British Medical Association. Winner of Sir Jamsetji Jijibhoy's "Medical Prize" in Medicine and Surgery, "Hunter Prize" in Ophthalmology, and "Cama Prize" for the best essay on the Sewerage of Bombay, awarded by the University of Bombay in 1884.

S. M. Kaka, D.P.H.

Bhaduri, Jyoti Bhushan,

Presidency College, Calcutta, India.

Lecturer, Presidency College. M.A. in Physics, Roy Prem Chand Scholar in Chemistry; Elliott Medallist for Original Investigation in Chemistry. Contributions: "On the Decomposition of Hydrochlorites." "Notes on the Estimation of Chlorine." Published in the *Journal of Asiatic Society*, Bengal 1896. "Note on the action of Nitric Acids on Alkali" in conjunction with Mr. Pedler, F.R.S., not yet published, but read on November 4th, 1896.

Alexander Pedler.

Rutter, Alfred,

Broken Hill, New South Wales, Australia.

Metallurgical Chemist. Chemist to the Broken Hill Proprietary Co. Associate of the Royal College of Science.

T. E. Thorpe.

W. C. Roberts Austen.

Unwalla, Rustomji Navroji,

Bhavnagar, Kathiawar, India.

Assistant Doctor and Chemical Analyser, Bhavnagar State Medical Department. Student Grant Medical College for 10 years. Passed in 1885 First Examination in L.M. and S., including Chemistry, Theoretical and Practical, Bombay University. Passed Final L.M. and S. fully in Medical Jurisprudence and Toxicology. Special work under Chemical Analyser (Government), Bombay, and under Mr. Hankin, Government Bacteriologist and Chemical Analyser, Agra.

Arthur Richardson.

PROCEEDINGS
OF THE
CHEMICAL SOCIETY.
EDITED BY THE SECRETARIES.

No. 175.

Session 1896-7.

February 18th, 1897. Mr. A. G. Vernon Harcourt, President, in the Chair.

Mr. E. Haynes Jeffers was formally admitted a Fellow of the Society.

Certificates were read for the first time in favour of Messrs. Herbert William Leyland Barlow, M.A., M.B., Holly Bank, Urmston, Manchester; Frederick Filmer de Morgan, Andely Lodge, Caeran Park, Newport, Monmouthshire; Louis Charles Deverell, Onslow House, Worthing; William James George Lasseter, B.A., 10, Stanley Road, Oxford; Harry Edward William Phillips, B.A., 47, Chalfont Road, Oxford; William Herbert Waite, B.A., Park Road, Halifax; Charles Thomas Foster Watts, 7, Cambrian Crescent, Chester; John Welsh, 12A, Seller Street, Chester.

The certificate of the following candidate, recommended by the Council under Bye-law I (3), was also read:—

Frederic Hewlett Burton-Brown, Simla, India.

It was announced that the following changes in the Officers and Council were proposed by the Council:—

As *President*—Professor James Dewar, M.A., LL.D., F.R.S., *vice* Mr. A. G. Vernon Harcourt, M.A., D.C.L., LL.D., F.R.S. As *Vice-Presidents*—Professor W. Ramsay, Ph.D., F.R.S., and Professor J. Emerson Reynolds, M.A., F.R.S., *vice* Professor James Dewar, M.A., LL.D., F.R.S., and Mr. Horace T. Brown, F.R.S. As *Ordinary Members of Council*—Messrs. C. T. Heycock, M.A., F.R.S.; Rudolph Messel, Ph.D.; Tom Kirke Rose, D.Sc.; and Alexander Scott, M.A., D.Sc., *vice* Messrs. Bernard Dyer, D.Sc.; G. Harris Morris, Ph.D.; W. A. Shenstone; and T. Stevenson, M.D.

It was also announced that the Council had awarded the Longstaff Medal to Professor William Ramsay, F.R.S., for the discovery of helium, and his share in the investigation of argon.

Messrs. H. Brereton Baker, F. D. Chattaway, and John Shields were appointed to audit the Society's accounts.

Of the following Papers, those marked * were read.

- *18. "The formation of dithionic acid in the oxidation of sulphurous acid by potassium permanganate." By T. S. Dymond and F. Hughes.**

When a solution of sulphurous acid is titrated with a solution of potassium permanganate, decolorisation of the permanganate ceases when only 89 per cent. of the quantity required to oxidise the sulphurous acid to sulphuric acid has been used. This is due to the formation of dithionic acid in addition to sulphuric acid. The proportion of dithionic acid produced is constant, and is not influenced by either the dilution or the temperature, or the acidity of the solution. Its production, therefore, appears to be an essential part of the reaction, and to be due to the weak oxidising action of the permanganate in a final stage of its reduction. The sulphuric and dithionic acids produced are in the proportion required by the supposition that manganese heptoxide is first reduced to the red oxide with production of sulphuric acid, and further reduced to the monoxide with production of dithionic acid. When, however, sulphurous acid is treated with the red oxide, sulphuric acid is the only product.

DISCUSSION.

The PRESIDENT said that he had worked, a number of years ago, upon the reaction between solutions of potassium permanganate and sulphurous acid, before sodium thiosulphate had come into use for estimating iodine. In making determinations without excluding air from the water, he had found that the quantity of permanganate used was far less than the amount necessary for the complete oxidation of the sulphurous acid. He found that the sulphurous acid was oxidised by the atmospheric oxygen dissolved in the water, and so progressively as the water gradually dissolved the oxygen in the air lying over it. As the result of a number of experiments, he proved that the diminution in the quantity of permanganate required increased with the dilution of the sulphurous acid, and also that if the water was boiled until air-free the quantity of permanganate used was larger, but he had not obtained such constant results as Messrs. Dymond and Hughes. He had tried the experiment of adding a small quantity of manganous sulphate to the dilute solution, and had found that this salt also was

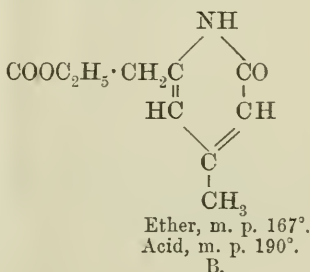
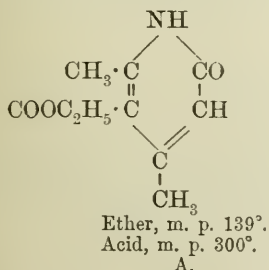
able to determine the oxidation of sulphurous acid by atmospheric oxygen. He thought the authors' experiments extremely interesting in showing the constant production of dithionic acid.

DR. SCOTT thought it would be worth while to try the effect of manganic sulphate in oxidising sulphurous acid.

PROFESSOR DUNSTAN suggested that it would be interesting to determine whether the formation of dithionic acid occurred at the positive electrode during the electrolysis of a solution of sulphurous acid, since it seemed possible that the dithionic acid might be formed by the oxidation of sulphurous acid in much the same way as persulphuric acid was formed by the oxidation of sulphuric acid. He understood that in the remarkable action of manganous sulphate described by the President this salt undergoes no change.

***19. "On the production of pyridine derivatives from ethylic- β -amidocrotonate." By J. Norman Collie, Ph.D., F.R.S.**

Amongst compounds from which pyridine derivatives can be obtained, ethylic acetoacetate stands out prominently. The author has already called attention to the fact that, when ethylic β -amidocrotonate is distilled, various pyridine compounds are formed. When the hydrochloride of ethylic β -amidocrotonate is heated to a temperature of about 120° , it at once condenses according to the equation $2C_6H_{11}NO_2HCl = C_{10}H_{13}NO_3 + NH_4Cl + C_2H_5OH + HCl$. This compound, $C_{10}H_{13}NO_3$, is the ethylic ether of an oxylutidine: it melts at $138-139^{\circ}$. If in its production the hydrochloride of ethylic β -amidocrotonate be heated with one molecular quantity of ethylic β -amidocrotonate, $C_6H_{11}NO_2HCl + C_6H_{11}NO_2 = C_{10}H_{13}NO_3 + NH_4Cl + C_2H_5OH$, an isomeric ether is obtained, m. p. $166-167^{\circ}$. The acids obtained from these two ethers melt respectively at $300-304^{\circ}$ and $190-191^{\circ}$, and both acids decompose at their melting point, lose carbon dioxide, and give pseudolutidostyryl.



Ether A, when boiled with soda, only hydrolyses with considerable difficulty. It does not react with acetyl chloride, hydroxylamine,

or nitrous acids; strong sulphuric acid dissolves it on warming, but the substance is precipitated unchanged when the mixture is poured into water. With bromine, a mono-substituted derivative is produced, $C_{10}H_{12}NO_3Br$, m. p. 158—159°. With phosphorus pentachloride, a chloro-lutidine derivative results, $C_{10}H_{12}NO_2Cl$, which is an oil, b. p. 288—290°. After prolonged treatment with tin and hydrochloric acid, the chlorine is removed and replaced by hydrogen, and an α - γ -dimethyl- β -ethylic carboxylate of pyridine, b. p. 246—248°, is obtained.

The acid obtained by the hydrolysis of ether A is very insoluble in water, but can best be recrystallised from that solvent; various attempts were made to convert this acid into the isomeric acid obtained from ether B, but without result.

Ether B, which is isomeric with ether A, is hydrolysed at once when added to soda solution and warmed. It gives a compound with phenylhydrazine, and when boiled with strong hydrochloric acid is decomposed; it is much less stable than ether A.

With bromine, it gives a di-substituted product at once, $C_{10}H_{11}NO_3Br_2$. This compound, when treated with soda, gives the sodium salt of a dibromo-acid, which acid melts at 227—228° with complete decomposition. Ether B gives on hydrolysis an acid, m. p. 190—191°, which can easily be crystallised from hot water; when melted it decomposes quantitatively into carbon dioxide and pseudolutidostyryl in exactly the same manner as the isomeric acid, m. p. 300—304°. Pseudolutidostyryl, $C_5H_3(CH_3)_2NO$, which is a dimethylpyridine derivative, was first obtained by Hantzsch (*Ber.*, 1884, 17, 2904) by the action of heat on a trimethylpyridine derivative. It was found on heating pseudolutidostyryl with zinc dust, that although some dimethylpyridine (lutidine) was formed, the chief product of the reaction was a trimethylpyridine (collidine).

Pseudolutidostyryl, when acted on by phosphorus pentachloride, gives α - γ -dimethyl- α -chloropyridine, b. p. 212—214°, and this compound when passed over heated zinc dust yields dimethylpyridine alone.

DISCUSSION.

DR. FORSTER drew attention to the apparent similarity between the reactions of the pyridine derivatives described by Dr. Collie and certain of the nitrogen derivatives of camphor when Tiemann's formula was employed.

DR. KIPPING was of opinion that there was no essential difference between Tiemann's formula for camphor and that proposed by Bredt. He thought that the possibility of the occurrence of tautomerism or

stereoisomerism in the compounds described by Dr. Collie should be kept in view.

DR. COLLIE, in reply, said he had not gone completely into the details of the various reactions he had made use of in preparing these substances, and he thought that when the full paper was read it would be seen that the substances were actually different in constitution, and not merely tautomeric or stereoisomeric.

***20. "Sodamide and some of its substitution derivatives." By A. W. Titherley, M.Sc., Ph.D.**

Sodamide in its reactions with organic haloid compounds invariably gives rise to complex decompositions without appreciable replacement of the halogen by NH_2 . The hydrogen of the sodamide, and not the sodium, reacts, giving hydrochloric acid, which with the amide yields ammonia, whilst the group $\text{NaN}=\text{}$ remains more or less intact, being found afterwards as sodium cyanide and sodium cyanamide. Charring invariably occurs, even when the reaction is conducted with care.

Sodamide on treatment with organic substances possessing a weak acid tendency, such as oximes and hydrazines, readily reacts, giving ammonia and sodium derivatives. In benzene solution these are obtained usually as fine crystalline precipitates, which may sometimes be crystallised from boiling benzene. Sodium acetoxime, sodium hydrazobenzene, sodium phenylhydrazine, and others have been thus obtained.

A series of substitution derivatives of sodamide formed by the replacement of one or both hydrogen atoms in NaNH_2 have also been prepared by the interaction of sodamide with (1) Aromatic amines; (2) Amides, according to the general equations:—(a) $\text{NaNH}_2 + \text{R} \cdot \text{NH}_2 = \text{NaNH} \cdot \text{R} + \text{NH}_3$; (b) $\text{NaNH}_2 + \text{R} \cdot \text{CONH}_2 = \text{NaNH} \cdot \text{CO} \cdot \text{R} + \text{NH}_3$.

In the former case, the reaction is conducted with the substances in the free state in an atmosphere of coal gas, and in the latter, in benzene solution.

Potassium ethylamide, KNHC_2H_5 , is formed by the careful action of ethylamine gas upon gently heated potassium. On heating, it readily decomposes into potassium cyanide, charcoal, and hydrogen. Sodium phenylamide, $\text{NaNH} \cdot \text{C}_6\text{H}_5$, sodium diphenylamide, $\text{NaN}(\text{C}_6\text{H}_5)_2$, sodium *p*-tolylamide, sodium β -naphthylamide, &c., are all very readily prepared by the above general reaction. They form white, greenish-yellow, or brown, amorphous solids with conchoidal fracture, or light yellowish powders, which are blackened and decomposed quickly in the air, darkening especially when moistened with benzene.

When sodamide reacts with organic amides (best in boiling benzene

solution) ammonia is rapidly evolved, and the substituted sodamides are obtained as fine, white, crystalline solids, those of larger molecular weight being appreciably soluble in benzene.

Sodium formamide, $\text{NaNH}\cdot\text{CO}\cdot\text{H}$, sodium acetamide, $\text{NaNH}\cdot\text{COCH}_3$, sodium propionamide, and sodium benzamide have been thus prepared—the latter apparently identical with the compound obtained by Curtius from the action of sodium upon benzamide by long-continued boiling in xylol solution.

The latter class of substituted sodamides are soluble without decomposition in alcohol, and their solutions, on treatment with alcoholic silver nitrate, throw down bright orange-red precipitates of the silver compounds, which are very unstable. From the colour of these silver derivatives, and the difficulty with which they and the sodium compounds appear to react with alkyl iodides, &c., the author concludes that the silver and sodium atoms, respectively, are directly attached to nitrogen, and that therefore the above derivatives are to be represented as possessing the ordinary amide and not the imido-hydroxy formula; the amides themselves are most probably tautomeric substances.

***21. "Rubidamide." By A. W. Titherley, M.Sc., Ph.D.**

Metallic rubidium behaves like the other alkali metals towards ammonia, displacing one atom of hydrogen and forming rubidamide RbNH_2 . Though not so energetic as in the case of lithium, the action is very rapid and commences in the cold. On heating in a silver boat to between $200\text{--}300^\circ$, oily drops of the amide quickly form and flow to a liquid in which the metal floats and partly dissolves to a deep blue solution, at once decolorised and converted into rubidamide by the action of ammonia. Rubidamide crystallises in plates melting at $285\text{--}287^\circ$, higher than sodamide and potassamide, but lower than lithamide. At 400° , it distils undecomposed in a current of ammonia. With water, it is violently decomposed, giving ammonia and rubidium hydrate. Alcohol also decomposes it and its behaviour with organic substances is very similar to that of sodamide or potassamide.

***22. "On the spectrographic analysis of some commercial samples of metals, of chemical preparations, and of minerals from Stassfurt potash beds." By W. N. Hartley, F.R.S., and Hugh Ramage.**

In continuation of the work already published (*Roy. Soc. Proc.*, 1896, 60, 393, and *Proc.*, 1897, 13, 11), samples were examined of steel made at Middlesbrough from the blast furnace metal smelted from Cleveland clay ironstone, and rolled into rails; of alumina and 'red mud'

separated from bauxite at the British Aluminium Co.'s Works at Larne, and of the aluminium prepared from the alumina at Foyers and of various commercial alums.

It is shown that of the constituents of the blast furnace metal, the alkali metals, calcium, copper, silver, gallium, manganese, and lead are present also in the steel, but the chromium and nickel have been removed.

Of the constituents of bauxite, traces of sodium, potassium, calcium, copper, silver, gallium, iron, manganese, and lead are found in the metallic aluminium. These elements are also present in larger quantities in the 'red mud' and in addition nickel and chromium are present.

The Alums.—Examined directly, by heating 0.5 gram of the dried sample in the oxyhydrogen flame, sodium, potassium, rubidium, calcium, and thallium are found as common constituents, and copper, gallium, iron, and nickel as occasional constituents. More interesting results were obtained by examining the precipitates produced by potassium ferrocyanide in solutions, containing 50 grams of the alum, strongly acidified with hydrochloric acid. These precipitates contained the elements sodium, potassium, rubidium, caesium, copper, silver, calcium, gallium, thallium, nickel, manganese, besides iron, which was also present in the acid radical. The rubidium, caesium, gallium, and thallium lines are strong in some of the spectra, and the results indicate that these elements are almost wholly precipitated by this process. A sample of "aluminoferric" from Messrs. Spence and Sons, Manchester, contained all the elements found in the alums, but in much larger quantities. Of these elements, the pyrites furnishes the thallium and also a trace of indium found in a bye-product of the manufacture of alum, whilst the other elements were traced to the aluminous minerals, bauxite and shale. The shale was richer in alkalis and gallium than the bauxite, but a sample of French bauxite was richer in silver and lithium than either Irish bauxite or shale.

Samples of Stassfurt minerals were examined in the course of the investigation, and were found to yield spectra containing no lines of rubidium, caesium, gallium, or thallium. These salts gave only weak lines of a few elements besides the lines of the principal elements composing them.

It is pointed out in the paper that the elements found by their spectra actually exist in the specimens, as there is no possibility of them being accidentally introduced, and furthermore, substances have been examined which have given no trace even of such widely distributed elements as potassium and calcium and in which the D lines are very weak.

The systematic examination of railway metal by such an analytical

method as is here employed might lead to results of practical importance. The method reveals the presence of small quantities of metals such as copper, silver, gallium and lead, which have not been considered in dealing with commercial irons, and the influences of which upon the physical properties of these have not been studied.

DISCUSSION.

DR. RIDEAL suggested that the calcium present in aluminium and its compounds might be derived from the vessels employed in the manufacture as well as from the bauxite. He thought it probable that calcium might be present as metal in commercial specimens of aluminium.

23. "Dissociation pressure of alkylammonium hydrosulphides." By James Walker, D.Sc., Ph.D., and John S. Lumsden, B.Sc., Ph.D.

The dissociation pressures of ammonium, ethylammonium, and dimethylammonium hydrosulphides have been determined, as well as the dissociation pressures of mixtures of these substances in pairs. The values obtained for the mixtures fell in every case considerably below the values calculated from the dissociation pressures of the components by the law of mass action. The ratios of the dissociation pressures of these substances, whether simple or mixed, are independent of the temperature, a fact which proves their heats of dissociation to be equal.

24. "Supposed condensation of benzil with ethyl alcohol. A correction." By Francis Robert Japp, F.R.S.

The author finds that the compound, described by him in a paper published jointly with Miss Owens (Trans., 1885, 47, 90), as formed by the condensation of benzil with ethyl alcohol, is in reality identical with Japp and Miller's *anhydracetonedibenzil*, $C_{31}H_{24}O_4$ (m. p. 194—195°), and that its formation was due to the presence of acetone in the "methylated spirit" (alcohol "denatured" with 10 per cent. of crude wood-spirit), which was used instead of duty-paid alcohol, in the preparation of the compound. The formula, $C_{30}H_{24}O_4$, ascribed to the condensation compound requires analytical figures differing only very slightly from those required by *anhydracetonedibenzil*.

At the time the paper was published, the authors believed the compound to be identical with Limpricht and Schwanert's *ethylidibenzoin*, $C_{30}H_{26}O_4$, which Jena stated that he had prepared by the action of alcoholic potash on benzil—the reaction employed by the authors. On the strength of this belief, they proposed to alter Limpricht and Schwanert's

formula to $C_{30}H_{24}O_4$, and they further cast doubt on the existence of an acetyl derivative which these investigators had prepared.

The author regrets the publication of these perfectly baseless criticisms on Linpricht and Schwanert's work.

The author is indebted to Professor Alexander Smith for privately informing him that he had not succeeded in preparing the compound from benzil and alcohol, and thus calling his attention to the matter.

25. "The viscosity of mixtures of miscible liquids." By T. E. Thorpe, F.R.S., and J. W. Rodger.

The authors having measured the viscosity of a large number of liquids, mostly carbon compounds and of very different types, at various temperatures up to the boiling points under a standard atmosphere (*Phil. Trans.*, 1894, 185A, 379; 1897, 189A), have made observations on mixtures of chemically indifferent and miscible liquids, with the view of throwing light on the relation of the viscosity of a mixture to the viscosity of its constituents. A sufficiently comprehensive study of this question would afford answers to many questions of interest. Thus it would settle whether viscosity was related to the number of molecules per unit volume or per unit surface, and would indicate, therefore, how viscosity observations, and indeed all observations which depend upon surface effects, should be treated. It would also indicate whether, in the case of a mixture of a simple and a complex liquid, the values of the viscosity gave any indication of the decomposition of molecular aggregates, and how such decomposition was related to dilution and temperature.

On the present occasion, the authors communicate the results of a series of measurements made at different temperatures on mixtures of carbon tetrachloride and benzene, methyl iodide and carbon disulphide, and ether and chloroform, the last pair of which they studied on account of the relatively considerable evolution of heat which accompanies their admixture. The methods of observation and of reduction were the same as those previously employed, and the apparatus was identical with that already described (*loc. cit.*).

In no case could the density of the mixture be calculated by the ordinary admixture rule. Carbon tetrachloride and benzene contract on mixing, as already found by F. D. Brown (*Trans.*, 1881, 39, 207); whereas methyl iodide and carbon disulphide expand. Ether and chloroform contract considerably.

As regards viscosity, the observations afford additional evidence of the fact indicated by Wijkander and supported by Linebarger, that the viscosity of a mixture of miscible and chemically indifferent liquids is rarely, if ever, under all conditions, a linear function of the com-

position. It seldom happens that a liquid in a mixture preserves the particular viscosity it possesses in the unmixed condition. To judge from the instances hitherto studied, the viscosity of the mixture is, as a rule, uniformly *lower* than the value calculated on the assumption that each constituent exercises an influence proportional to its amount, although many examples are known to the contrary. No simple relation can as yet be traced between the viscosity of a mixture and that of its constituents.

In the case of a mixture of ether and chloroform, the viscosity at low temperatures is *greater* than the admixture rule would indicate, but as the temperature is raised, or as the mixture giving the maximum contraction is diluted, the viscosity eventually becomes *less* than the calculated value, when the general course of the curve showing the relation of viscosity to composition resembles that of such mixtures as carbon tetrachloride and benzene, or of methyl iodide and carbon disulphide. The phenomena in the case of a mixture of ether and chloroform would seem, to begin with, to be analogous to those of a mixture of ethyl alcohol and water, but the condition which determines the contraction and the maximum viscosity, whether it be a feeble chemical combination or a molecular aggregation of a purely physical character, is destroyed by heat or dilution.

26. "Magnesium nitride as a reagent." By H. Lloyd Snape, D.Sc., Ph.D.

The object of the experiments detailed in this paper was to investigate whether magnesium nitride could be utilised to introduce nitrogen in the place of oxygen, chlorine, and other negative elements which combine with magnesium. The author investigated the behaviour of magnesium nitride towards chloroform, carbon trichloride, and benzaldehyde respectively, in the hope that the reactions represented by the following equations would occur:—(1) $2\text{CHCl}_3 + \text{Mg}_3\text{N}_2 = 3\text{MgCl}_2 + 2\text{HCN}$; (2) $\text{C}_2\text{Cl}_6 + \text{Mg}_3\text{N}_2 = 3\text{MgCl}_2 + \text{C}_2\text{N}_2$; (3) $3\text{C}_6\text{H}_5\cdot\text{CO}\cdot\text{H} + \text{Mg}_3\text{N}_2 = 3\text{MgO} + (\text{C}_6\text{H}_5\cdot\text{CH})_3\text{N}_2$. The substances to be treated with magnesium nitride were sometimes passed in the form of vapour over the latter compound, and sometimes directly mixed with it, the mixture being heated in a sealed tube.

In no case was the desired nitrogenous compound obtained. The chloroform was not attacked at temperatures at which hydrocyanic acid could exist without decomposition, but at higher temperatures an energetic reaction took place, and the observed results were consonant with the reaction $2\text{CHCl}_3 + \text{Mg}_3\text{N}_2 = 3\text{MgCl}_2 + \text{C}_2 + \text{N}_2 + \text{H}_2$. Carbon trichloride and benzaldehyde were likewise unaffected at temperatures below those at which the anticipated products could be formed. On

heating with benzaldehyde to about 240° , a crystalline product, identical with that described by Laurent as amarone, was obtained. Both were subsequently discovered to be identical with the substance named tetraphenylazine by Japp and Burton. (See also the following paper.)

27. "The identity of Laurent's amarone with tetraphenylazine." By H. Lloyd Snape, D.Sc., Ph.D., and Arthur Brooke, Ph.D.

Amarone being required to compare with the substance obtained, as described in the preceding paper, by the action of magnesium nitride upon benzaldehyde, the authors repeated Laurent's experiments.

It was necessary, in the first instance, to prepare benzoylazotide. This, it was found, could be more readily prepared than by the methods previously given, by the action of ammonium cyanide upon benzaldehyde. Laurent had stated that benzhydramide was produced by the long continued action of ammonium cyanide upon benzaldehyde, but this was probably due to his having employed an excess of the former reagent. The formula given by Laurent to benzhydramide would accord with its formation by treating benzoylazotide with benzaldehyde, $C_6H_5 \cdot CO \cdot H + C_{15}H_{12}N_2 = C_{22}H_{18}N_2O$. The authors propose to try whether such a reaction can actually be carried out. The vapours of ammonium cyanide were conducted into a mixture of benzaldehyde and alcohol. Crude benzoylazotide slowly separated out, and was washed with alcohol and recrystallised from benzene. The crystals softened at 198° , and completely melted, with attendant decomposition, at 202° . They were readily soluble in benzene and chloroform; difficultly soluble in alcohol and carbon disulphide, scarcely at all soluble in ether, and insoluble in water. An estimation of nitrogen established their identity with the benzoylazotide previously obtained by other methods.

To prepare amarone, benzoylazotide was next subjected to dry distillation under a pressure of 21 mm. The residue left, after hydrocyanic acid and other comparatively volatile vapours had been removed, was crystallised from alcohol containing a small quantity of hydrochloric acid, and washed with some more of the same solution to extract any residual lophine. The crystals which were left melted at 243 to 244° , dissolved in concentrated sulphuric acid giving the characteristic red solution, and behaved towards other solvents precisely in the same manner as the crystalline substance previously prepared from magnesium nitride and benzaldehyde.

By analysis, it was found that the empirical formula of amarone was $C_{14}H_{10}N$, not $C_{16}H_{11}N$, as had been stated by Laurent. The amarone which he obtained was evidently not pure, its melting point being only 233° , or about 10° lower than that of the purified material.

Moreover, a comparison of the properties of pure amarone showed it to be identical with the substance named by Japp and Burton tetraphenylazine, $C_{28}H_{20}N_2$. The authors were kindly supplied by Professor Japp with some of the latter compound, prepared by him from benzoin, for the purpose of instituting this comparison. It was thus established that amarone, as described by Laurent, was actually tetraphenylazine.

It seems probable to the authors that the substance obtained by Curtius and Blumer having the same empirical formula, $C_{14}H_{10}N$, to which they have not assigned a structural formula, will likewise prove to be tetraphenylazine. The properties of this compound, so far as they have been described, agree with this supposition.

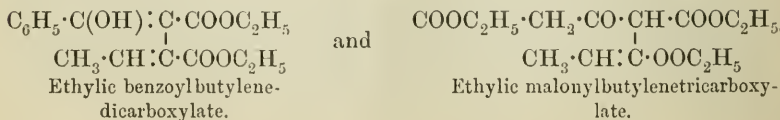
28. "Studies on the interaction of highly purified gases in presence of catalytic agents. Part I." By Wm. French, M.A.

In absence of light, spongy platinum does not appear to bring about combination between oxygen and hydrogen if they have been previously carefully dried; and, so far, experiments seem to show that, after the gases have been in contact with the platinum, added moisture does not cause an explosion.

29. "Contributions to the knowledge of the β -ketonic acids. Part III." By S. Ruhemann, Ph.D., M.A.

The author arrives at the conclusion, from the further study of the action of ethylic chlorofumarate and ethylic α -chlorocrotonate on ethereal salts of β -ketonic acids, that the substances described before (Trans., 1896, 69, 530, 1383) are to be regarded as ketone-compounds, and he gives the corrections necessitated by the change of view concerning the constitution of the various products there recorded. He further shows that the substance formed from ethylic chlorofumarate and ethylic acetomethylacetate is to be looked upon as ethylic acetoallylenedicarboxylate, $CH_3 \cdot CO \cdot C(COOC_2H_5) : C : CH \cdot COOC_2H_5$. Aniline acts on this ethereal salt with formation of an anile-compound which crystallises in yellow plates (m. p. 180°).

Ethylic benzoylacetate and ethylicacetonedicarboxylate form, with ethylic α -chlorocrotonate, compounds which are to be represented by the formulæ



The latter substance, under the influence of ammonia, yields two isomeric diamides of the ethereal salt, having the formula $C_{11}H_{16}N_2O_5$, besides a diamide of the corresponding acid.

30. "Contributions to the knowledge of the β -ketonic acids. Part IV." By S. Ruhemann, Ph.D., M.A., and A. S. Hemmy, B.A., M.Sc.

Ethylic acetosuccinate was found to give a colour reaction with ferric chloride, in opposition to the statement of Conrad (*Annalen*, 1877, 188, 218). The authors give an account of various substances formed from this ethereal salt under the influence of ammonia and of phenylhydrazine. In the latter case, ethylic methylphenylpyrazolone acetate is formed, which, on hydrolysis, yields the corresponding acid. The bromo-derivative of ethylic acetosuccinate was prepared, and on distillation in a vacuum gave ethylic carbotetrinate (*cf.* Moscheles and Cornelius, *Ber.*, 1888, 21, 2603).

Ethylic benzoylsuccinate, obtained according to Perkin's directions (*Trans.*, 1885, 47, 272), was found to distil without decomposition at 192—193° at 10 mm., and to be decomposed by ammonia with formation of succinamide.

31. "Oxidation of phenylstyrenyloxytriazole." By George Young, Ph.D.

The oxidation by alkaline potassium permanganate of phenylstyrenyloxytriazole, $C_6H_5 \cdot CH:CH(C_6H_5) \cdot C_2N_3 \cdot OH$, yields phenyloxytriazole carboxylic acid, $C_6H_5 \cdot C_2N_3(OH)CO_2H$. This acid, immediately on liberation, loses carbon dioxide and forms phenyloxytriazole,
$$\begin{array}{c} C_6H_5 \cdot N \cdot N \\ | \\ HC:N \end{array} \gg COH.$$

The following derivatives of the carboxylic acid have been prepared. Ethylic phenylethoxytriazole carboxylate, $Ph \cdot C_2N_3(OEt)CO_2Et$, white needles, m. p. 82—83°. Amide, $C_6H_5 \cdot C_2N_3(OC_2H_5)CONH_2$, white needles, m. p. 149—150°. Silver salt, $C_6H_5 \cdot C_2N_3(OC_2H_5)CO_2Ag + 2H_2O$. Phenylethoxytriazole carboxylic acid, when liberated, loses carbon dioxide and forms phenylethoxytriazole, $C_6H_5 \cdot C_2N_3H \cdot OC_2H_5$, needles, m. p. 60°. This compound has also been formed by the action of ethyl iodide on the silver derivative of phenyloxytriazole.

32. "Apiin and apigenin." (Preliminary notice). By A. G. Perkin.

Apiin, a constituent of parsley (*Apium petroselinum*), was first isolated by Braconnot (*Ann.*, 1843, 48, 349), and subsequently examined by Planta and Wallace (*Ann.*, 1850, 74, 262), who found it consisted of a glucoside. Gerichten (*Ber.*, 1876, 9, 1124), in a more detailed investi-

gation, assigned it the formula $C_{27}H_{32}O_{16}$, and considered its decomposition by dilute acids to be most probably represented by the equation $C_{27}H_{32}O_{16} + H_2O = C_{15}H_{10}O_5 + 2C_6H_{12}O_6$, which is based upon the yield of apigenin thus obtained. He described no derivatives of apigenin, but states that by the action of alkali there is produced phloroglucol and an acid, which by prolonged treatment, is decomposed with formation of protocatechuic acid, *p*-hydroxybenzoic acid, formic and oxalic acids.

Having suspected, from a description of its properties, that apigenin was a yellow colouring matter, and this having been proved to be the case, the present investigation was instituted. It is wished to reserve the further study of the reactions of this interesting substance.

The glucoside apiin is somewhat difficult to fully decompose by dilute acids, the apigenin produced after 3 hours' digestion with hydrochloric acid of sp. gr. 1.04 yielding $C = 64.3$; $H = 3.90$; after 10 hours, $C = 65.81$, 65.74 ; $H = 3.45$, 4.01 ; and only when so treated for 25 hours are numbers obtained indicating the formula $C_{15}H_{10}O_5$, evidently the correct one. Calc., $C = 66.66$; $H = 3.70$; Found, $C = 66.34$, 66.37 ; $H = 3.87$, 3.81 . Apigenin contains no methoxy-groups, and does not combine with mineral acids; it, however, forms a sulphonic acid not yet thoroughly examined. Dibromapigenin crystallises in almost colourless needles, melting above 290° . $C_{15}H_8O_5Br_2$ requires $C = 42.05$; $H = 1.87$; Found, $C = 42.09$; $H = 2.23$; and a tribenzoyl compound, $C_{15}H_7O_5(C_7H_5O)_3$, needles, m. p. $210-212^\circ$ has also been obtained. Calc., $C = 74.23$; $H = 3.78$. Found, $C = 74.41$; $H = 4.17$. Apigenin reacts with diazobenzene, forming $C_{15}H_8O_5(C_6H_5N_2)_2$, orange-red needles, m. p. $290-292^\circ$. Calc., $C = 67.78$; $H = 3.74$; $N = 11.71$. Found, $C = 67.22$; $H = 3.75$; $N = 11.54$, 11.56 ; which yields a monacetyl derivative $C_{15}H_7O_5(C_2H_3O)(C_6H_5N_2)_2$; orange-red leaflets, m. p. $259-260^\circ$. Calc., $C = 66.92$; $H = 3.84$. Found, $C = 66.66$; $H = 4.05$. Experiments on the further acetylation of this substance are in progress. By treatment with strong alkali, there is obtained from apigenin, phloroglucol, an acid, m. p. $208-209^\circ$, probably *p*-hydroxybenzoic acid, a trace of acetic acid, and a substance crystallising in colourless needles, m. p. 107° , which bears some resemblance to *p*-hydroxyacetophenone. Fuming nitric acid decomposes apigenin, the principal product being an acid; yellow needles, m. p. $244-245^\circ$. The dyeing properties of apigenin will be described in the full communication. The investigation of these substances will be continued, and the study of the ethylation and methylation of apigenin is also in progress.

33. "Note on the constitution of the so-called 'nitrogen iodide.'"
By J. W. Mallet, F.R.S.

Mr. Chattaway concludes his paper by saying that "at present the formula NH_3I_2 seems best to accord with the reactions of the compound as a whole, and best to group all the known facts regarding it." Reference to a short paper by my sometime student, Mr. W. H. Seamon, published in the *Chemical News*, 1881, 44, 188, will show that a very different substance—liquid, and non-explosive—gives results on analysis agreeing well with this formula. It was obtained by the action of dry, gaseous ammonia on solid iodine, and appears to be identical with the substance prepared in a different way by Guthrie, of which brief mention is made by Mr. Chattaway in a footnote.

I cannot agree with him that in the explosive compound the ratio of N:I is always 1:2. Some analytical results of my own (published in the paper on this subject in the *American Chemical Journal*, 1879, 1, 4) were quite incompatible with this ratio, and agreed nearly with the ratio 1:3. In view of the fact that the preparation which gave these results had been freely washed with alcohol and afterwards with ether, I cannot think it probable that any considerable formation and retention of iodoform raised the proportion of iodine.

In any discussion of the composition of the explosive substance in question, some attention ought surely to be given to the probable analogy with nitrogen trichloride, for which Gattermann seems to have fairly well established the formula.

CERTIFICATE OF CANDIDATE FOR ELECTION
AT THE NEXT BALLOT.

The Certificate of the following Candidate is recommended by the Council under Bye-law I. (3).

Burton-Brown, Frederic Hewlett,

C/o Surgeon-General, Government of India, Simla.

Surgeon-Captain, Indian Medical Service. M.A. Oxford. At present engaged in the study of the Indian Materia Medica. Late Demy (Natural Science), Magdalen College, Oxford; 1st Class, Honour School Natural Science, Oxford, 1886. Late Professor of Materia Medica, University of the Punjab. Author of "A Note on the Chemistry of Milk with reference to Hammersten's Investigations on

Casein," published in the *Proceedings of Physiological Society*, 1886. Worked in 1883-4 in Laboratory of the late Professor C. Fr. W. Krukenberg, of Jena. The results of investigations undertaken for the professor were published in his *Die vergleichende Physiologie*; these referred to the spectra of certain organic compounds.

Wyndham R. Dunstan.

At the next Meeting, on Thursday, March 4th, there will be a ballot for the election of Fellows, and the following Papers will be received. The authors of those marked with an asterisk have announced their intention of being present.

* "Some hydrocarbons from American petroleum. I: Normal and Iso-pentane." By Sydney Young, D.Sc., F.R.S., and G. L. Thomas, B.Sc.

* "The vapour pressures, specific volumes and critical constants of normal pentane; with a note on the critical point." By Sydney Young, D.Sc., F.R.S.

* "On the freezing-point curves of alloys containing zinc." By C. T. Heycock, F.R.S., and F. H. Neville.

* "The oxides of cobalt and the cobaltites." By A. H. McConnell and E. S. Hanes.

PASTEUR MEMORIAL LECTURE.

The Pasteur Memorial Lecture will be delivered by Professor Percy Frankland, Ph.D., F.R.S., at an extra meeting of the Society on Thursday, March 25th, at 8 p.m.

ANNIVERSARY MEETING.

The Anniversary Meeting will be held on Wednesday, March 31st, at 3 o'clock in the afternoon.

ANNIVERSARY DINNER.

It has been arranged that the Fellows of the Society and their friends shall dine together at the Criterion Restaurant on Wednesday, March 31st, at 7 p.m. *The Secretaries will be glad to receive early notification from those Fellows who intend to be present.*

PROCEEDINGS

OF THE

CHEMICAL SOCIETY.

EDITED BY THE SECRETARIES.

No. 176.

Session 1896-7.

March 4th, 1897. Mr. A. G. Vernon Harcourt, President, in the Chair.

Certificates were read for the first time in favour of Messrs. Alarie Vincent Colpoys Fenby, B.Sc., Hutton Grammar School, Preston; R. Glode Guyer, 20 Queen's Road, St. John's Wood, N.W.; Tom Mitchell, Cemetery House, Shaw, near Oldham; Robert Howson Pickard, B.Sc., Southfield, Priory Road, Edgbaston, Birmingham.

MR. CASSAL asked whether the officers had withdrawn the Certificate of a Candidate from the list to be balloted for that evening.

PROFESSOR THOMSON stated that the Certificate of one of the Candidates had been postponed pending further information.

DR. ARMSTRONG remarked that such action had been taken by the officers on former occasions, and was within their discretion.

The following were duly elected Fellows of the Society:—Messrs. John Owen Alexander; Thomas Hannibal Aquino; William Arbuckle; John B. Ashworth; John Barclay, B.Sc.; Frank Bastow; Jyoti Bhushan Bhaduri, M.A.; James Herbert Brown; F. Hewlett Burton-Brown, M.A.; Alfred Cartmell; Masumi Chikashigé, B.Sc.; Alfred Foster Cholerton; Clarence Hamilton Creasey; James Crowther, B.Sc.; William Alfred Davis; William Diamond; John Wallis Dodgson, B.Sc.; Lawrence Dufty; William Buckland Edwards; Joseph Lake Gibbons; Alexander W. Gilbody, M.Sc., Ph.D.; Harold Walter Gough, B.A.; Ernest Goulding; Edward Graham Guest, M.A.; Vaughan Harley, M.D.; Ernald G. Justinian Hartley, B.A.; Thos. Hartley; Charles Heppenstall; John Holmes; Fred Ibbotson, B.Sc.; William Rose Innes, B.Sc., Ph.D.; David Smiles Jerdan, M.A., B.Sc.; Harold Johnson; Otis C. Johnson; Herbert King; William Robert

Lang, B.Sc.; Theophilus Henry Lee; Charles Henry Martin; Barker North; Charles Henry Parker; Samuel Pollitt, B.Sc.; Herbert Spindler Pullar; William Ralston, B.Sc.; John Stewart Remington; Edward Rosling; Alfred Rutter; Frank Southerden; William James Stainer, B.A.; Henry Potter Stevens, B.A.; Leonard Sumner, B.Sc.; Harry Thompson; Andrew Turnbull, Ph.D.; Basil William Turner; Rustomji Navroji Unwalla; Samuel Matthew Walford; J. Wallace Walker, M.A., Ph.D.; and Meyer Wilderman, Ph.D.

In accordance with the bye-law, the lists of the names of the Fellows recommended for election as official and ordinary Members of Council were read from the Chair.

Of the following Papers, those marked * were read.

- *34. "Some hydrocarbons from American petroleum. I. Normal and Iso-pentane." By Sydney Young, D.Sc., F.R.S., and G. L. Thomas, B.Sc.

The two pentanes were separated by fractional distillation from the "pentane" supplied by Merck of Darmstadt. This substance, which is obtained by the distillation of American petroleum, is a complex mixture of butanes, pentanes, and hexanes, with some benzene and a little hexanaphthene. A combination of a dephlegmator with a constant (or rather 'regulated') temperature still-head was employed; the apparatus is fully described in the paper.

Some of the constants of isopentane were determined so as to compare them with those of the two specimens prepared synthetically: the agreement was found to be very satisfactory. The boiling points under normal pressure are:—isopentane 27.95° ; normal pentane 36.3° . The specific gravities at 0° are:—isopentane 0.63930, normal pentane 0.64539.

- *35. "The vapour pressures, specific volumes and critical constants of normal pentane; with a note on the critical point." By Sydney Young, D.Sc., F.R.S.

The critical temperature of normal pentane is 197.2° , the critical pressure is 25,100 mm. and the critical volume of a gram 4.303 c.c. The vapour pressures and specific volumes were determined from low temperatures to the critical point, and the observations were taken as near to the critical point as possible (197.15°), in order to obtain more complete experimental evidence regarding the condition of a substance at and very near that point.

The ratios of the absolute temperatures (boiling points) and volumes

to the critical constants, also the ratio of the actual to the theoretical density at the critical point (3.765), lead to the conclusion that, at the critical temperature and in the liquid state, the molecules are simple, like those of the gas.

DISCUSSION.

The PRESIDENT said that for many years he had been interested in the isopentane derived from American petroleum, having proposed that its flame should be used, under specified conditions, as a standard of light. He had purified it by shaking with sulphuric acid, and afterwards with soda. He had no doubt it was an improvement to use nitric acid, as Dr. Young had done. He had used a dephlegmator very similar to that described, but had never succeeded by fractional distillation in obtaining a substance of such a constant boiling point as that obtained by Dr. Young. He was much interested to hear this proof by Dr. Young of the identity of isopentane with that which is obtained from amyl iodide, as experiments on the illuminating power did not quite settle this question.

DR. ARMSTRONG thought that it was not quite certain that the isopentane used by Dr. Young was a single thing, and it was probably very difficult to obtain satisfactory proof of purity. In the case of the specimen derived from amyl alcohol, he considered it likely that this was a mixture of two hydrocarbons, as it did not appear that the amyl alcohol of fusel oil had first been separated into its two constituents.

DR. CRAW said that Dr. Young seemed to have shown that the critical temperature could be determined accurately for the class of compounds on which he had worked; but he asked whether the critical temperature is capable of being determined with the same accuracy for all classes of compounds.

MR. GROVES agreed with Dr. Armstrong as to the necessity of taking special precautions in purifying materials and of not trusting to those supplied by manufacturers.

DR. THORPE said he had had some experience in the preparation of isopentane. He had obtained it from amyl alcohols of very different origin. The question was whether the isopentane derived from fusel oils of very different origin would give the same hydrocarbon. He had found that all the specimens of isopentane gave practically the same boiling-point and density numbers as those obtained by Dr. Young. Nevertheless, Mr. Rodger and he had found that the viscosities of isopentane derived from different sources varied considerably, and it was significant that their specific volumes and specific gravities agreed closely with those recorded by Dr. Young. In the case of other liquids differently prepared and purified, the same viscosity numbers

were obtained; for example, Professor Dunstan had provided him with a sample of pure ether and Dr. Perkin also provided him with a sample, and the viscosities of the two were in perfect agreement. Similarly, he had compared two samples of benzene of different origin, and here also the two samples gave the same viscosity number. On this account he was inclined to question the homogeneity of isopentane prepared from amyl alcohol.

DR. YOUNG, in reply, said he had spent many months in purifying the materials and was satisfied that they were pure. He was, indeed, surprised that doubt should be cast upon the matter.

In the fractionation of the pentane and isopentane, he started with considerable quantities of materials, about 1,500 grams, and he obtained about 110 grams of pure substance. The liquid was fractionated about 20 times, and the loss was nearly 20 grams in each fractionation. There were only, as far as he knew, three isomeric pentanes, and as they had distinctly different boiling points, he did not see that there could be any mistake as to their identity. The critical temperatures and pressures are very delicate tests of the purity of the substance. With slightly impure ether, the difference in critical pressure is very considerable.

With regard to the fractionation of pentane and isopentane, the ordinary methods of fractional distillation would not answer. With the ordinary still-head, the loss by evaporation was greater than the gain by distillation, but the regulated still-head he had used gave most satisfactory results. He had no hesitation in saying that, with all substances which do not undergo decomposition when heated, the critical point can be determined within one-tenth of a degree.

***36. "On the freezing-point curves of alloys containing zinc." By C. T. Heycock, F.R.S., and F. H. Neville.**

The paper is divided into two sections, the first dealing with cases where the freezing point of zinc is depressed by the addition of another metal, the second with the cases where it is raised by such an addition.

In section I, complete binary alloys of the following pairs of metals, zinc-cadmium, zinc-aluminium, zinc-tin and zinc-bismuth, are given. In the first three cases the metals appear to be miscible with each other in all proportions, but for zinc-bismuth the freezing-point curve shows the horizontal line of identical freezing points characteristic of the state when the alloy has separated into two conjugate liquids.

Taking the freezing point of zinc as 419° , the authors find for the temperatures of freezing and the composition of the eutectic mixtures the following

Alloy.	F.P.	Atomic percentage of Zinc.
Zn—Cd.	264.5	74
Zn—Al.	281	11
Zn—Sn.	198	84
Zn—Bi.	254.5	91.8

They do not consider that there is any indication of these metals combining chemically to form definite compounds when they are melted together.

Dilute solutions of the following metals in zinc were also examined : lead, thallium, antimony, magnesium.

The authors find that, with the exception of aluminium and cadmium, all the above-mentioned metals, when added in small quantities to molten zinc, cause the same atomic fall : that is, an alloy containing 1 atomic weight in solution in 99 atomic weights of zinc has a freezing point lower by 5.1° than that of pure zinc. Cadmium causes a somewhat smaller and aluminium a decidedly smaller depression. The atomic depression of 5.1° , when used with Van 't Hoff's equation for the latent heat, gives 28.3 calories for the latent heat of fusion of zinc, instead of Person's value of 28.13.

In section II, dilute solutions of copper and of gold in zinc are considered, and also a complete freezing point curve for all alloys of zinc and silver.

When small quantities of any one of these three metals are added to molten zinc the effect is the same : the freezing point is raised, and the whole mass of metal appears to solidify at a temperature above the freezing point of pure zinc. The rise in the freezing point, moreover, is proportional to the amount of the second metal present. But when as much as 2 atomic per cents. of silver or of copper or 3.3 of gold have been added the phenomenon alters, apparently abruptly. There are now two freezing points, a higher one which is very fugitive, and which is followed by the precipitation of much solid, and a lower one which is very constant, and which is independent of the amount of the added metal so long as the above-mentioned minimum is present. In the zinc-silver curve singularities are also found near 70 and 60 atomic per cents. of zinc, indicating the existence of more or less stable compounds, but the formula of these compounds is uncertain. Near 37.5 atomic per cents. of zinc there is another well-marked angle and a series of eutectic second freezing points, the phenomenon being possibly due to the separations of the alloy into conjugate liquids.

The authors also describe briefly some of the physical properties of the zinc-silver alloys, which appear to change in character at the angles of the curve.

The composition of the silver zinc alloys at each freezing point was

determined by extracting a portion in the liquid state, and estimating the percentage of silver by a volumetric analysis.

DISCUSSION.

MR. NEWLANDS asked whether the formulæ of the compounds which were supposed to exist at certain points, viz., AgZn , AgZn_2 , and AgZn_3 , represented atoms of the metals, or only that the metals were present in that proportion.

MR. GROVES asked whether there was any connection between the colour of the silver-zinc alloy and any of the points on the curve.

MR. JENKINS asked whether the colour of the alloy was in any way due to the effect of mechanical stress during sudden cooling.

DR. CRAW asked whether the atoms in the alloy were in the monatomic state, and whether the alloy might be compared with a solution.

MR. NEVILLE, in reply, said the formulæ were only empirical. They were disposed to think that the dissolved metal was in a monatomic state. The colour of the alloy did not seem to have any connection with the points on the curve, and although great mechanical stress occurred in its production, this did not seem to afford an explanation of the colour.

*37. "The oxides of cobalt and the cobaltites." By Arthur H. McConnell and Edgar S. Hanes.

The authors describe a method for the preparation of alkali cobaltites, and show that cobalt forms an oxide, CoO_2 , and an acid, H_2CoO_3 , which have hitherto been looked upon as hypothetical, and a series of alkali salts on the type of potassium cobaltite, K_2OCoo_2 . The conclusions the authors arrive at are as follows.

(1) That Durrant (Proc., 1896, 12, 96, 244) has not produced sufficient evidence for the existence of either cobaltic acid or cobalt percarbonate.

(2) That cobaltous acid corresponds with cobalt dioxide, and forms alkali salts fairly stable in solution, which solutions have an unmistakable green colour.

(3) That cobalt forms a series of compounds with other metals in which the cobalt is part of the acid radicle.

(4) That cobaltous acid and cobaltites are strictly analogous to manganous acid and manganites, thus showing that the properties of cobalt are closely allied to those of the other elements associated with it in the periodic classification. Manganese is readily oxidised to the peroxide MnO_2 , but cobalt much less readily yields the corresponding peroxide CoO_2 .

(5) In view of the fact that cobalt dioxide does undoubtedly exist in a number of compounds, the authors suggest that the oxides of cobalt should be renamed, to bring them into line with the corresponding oxides of manganese.

(6) It is highly improbable that the formation of this green solution will prove to be of any use for the separation of cobalt from nickel, either quantitatively or qualitatively.

***38. "A new synthesis in the sugar group." By Henry J. Horstman Fenton, M.A.**

In previous communications, it has been shown that the acid (dihydroxymaleic acid) obtained by oxidation of tartaric acid in presence of iron decomposes, on heating with water, almost quantitatively into glycollic aldehyde and carbon dioxide. Also, that this aldehyde, when heated in a vacuum, undergoes condensation, yielding a sweet-tasting, solid gum which has the formula $C_6H_{12}O_6$.

The present paper describes an investigation which has been made upon the properties of this condensation product.

It is easily soluble in water, and its solution quickly reduces Fehling's solution and ammoniacal silver nitrate. It gives various colour-reactions characteristic of 'sugars,' and, after purification with alcohol, yields, with phenylhydrazine, a normal hexosazone, $C_{18}H_{22}N_4O_4$ melting at $168-170^\circ$. Heated with water to 140° , it yields furfural. It is optically inactive, and appears to be incapable of fermentation by yeast.

The purified 'sugar,' when further heated in a vacuum to $100-106^\circ$, loses water and becomes hard and brittle. After 2-4 hours' heating it has the composition $C_{12}H_{22}O_{11}$ and after 24 hours' heating the composition nearly approximates to $C_6H_{10}O_5$.

The conditions under which tartaric acid may be converted into dihydroxymaleic acid by atmospheric oxygen exhibit close analogies with some of the essential conditions of vegetable growth; and it is suggested that the direct production of a 'sugar' in the manner above indicated may possibly help to throw light upon the natural formation of carbohydrates.

39. "The dinitrosamines of ethylene aniline, the ethylene toluidines and their derivatives." By Francis E. Francis, Ph.D., B.Sc.

The dinitrosamine of ethylene aniline gives *p*-di-nitrosoethylene aniline hydrochloride on treatment with a mixture of glacial acetic and hydrochloric acids, and the resulting tetramine yields quinone on oxidation, showing that it is a *p*-diamine, ethylene *p*-phenylene diamine. The

di-nitrosamines of ethylene *o*-toluidine and ethylene *m*-toluidine yield di-nitroso compounds, which on reduction pass into corresponding tetramines, whereas the di-nitrosamine of ethylene *p*-toluidine is decomposed. This clearly shows that in the substances investigated the nitroso-group can only pass under the treatment described to the *p*-position in the benzene nucleus.

40. "Contribution to the knowledge of the β -ketonic acids." Part.V. By S. Ruhemann, M.A., Ph D., and A. S. Hemmy, B.A., M.Sc.

Whilst studying the interaction between the sodium derivative of ethylic oxalacetate and ethylic chlorofumarate, the authors observed the formation of two isomerides of the formula $C_{14}H_{16}O_8$. One of them, melting with decomposition at 200° , forms blue salts with alkalis which, by an excess of the reagent, become colourless. The other, which melts at 123° , does not yield coloured salts, but gives a dark red coloration with ferric chloride. The authors arrive at the view that in the formation of these compounds, ethylic oxalacetate alone takes part, and they represent the constitution of the substance decomposing at 200° by the

formula,
$$\begin{array}{c} \text{COOC}_2\text{H}_5 \cdot \text{C} \equiv \text{C} \cdot \text{COOC}_2\text{H}_5 \\ \text{OC} \cdot \text{COH} : \text{C} \cdot \text{COOC}_2\text{H}_5 \end{array}$$
 (ethylic anhydro-oxalaconitate),

the other by the symbol,
$$\begin{array}{c} \text{COOEt} \cdot \text{C} \cdot \text{O} \cdot \text{COOEt} \\ \text{HC} \cdot \text{CO} \cdot \text{C} \cdot \text{COOEt} \end{array}$$
 (ethylic pyronetricarboxylate).

41. "Enantiomorphic forms of ethylpropylpiperidonium iodide." By Clare de Brereton Evans.

It has been found that ethylpropylpiperidonium iodide ($C_5H_{10}EtPrNI$) may be obtained from its solution in absolute alcohol, in right-handed and left-handed crystals. The enantiomorphism, however, is of a purely crystallogenic order, due to the arrangement of the molecules in the crystal, and not to the position of the atoms in space. This is proved by the optical inactivity of the substance in solution, as well as by the fact that either variety may be converted into the other by recrystallisation, the behaviour being like that observed in the case of sodium chlorate and bromate, &c., &c.

42. "Further note on ketopinic acid—pinophanic acid." By W. S. Gilles and F. F. Renwick.

The further investigation of the acid obtained by oxidising the solid hydrochloride from pinene with the strongest nitric acid (*Trans.*, 1896, 69, 1397), has brought to light a variety of interesting points.

Although bromine alone does not attack it, ketopinic acid is readily

brominated if a small quantity of phosphorus be present; the product has the formula $C_{10}H_{13}O_3Br$. (C = 46.18; 46.06; H = 4.96, 5.00; Br = 30.70. Calc. C = 45.98; H = 4.98; Br = 30.66). Monobromoketopininc acid melts at 181° ; it is readily soluble in ether, acetone, acetic acid, and ethylic acetate, but sparingly so in benzene, chloroform, and hot water. When heated with aniline or quinoline, it is reconverted into ketopininc acid.

The hydroxime of ketopininc acid is merely hydrolysed when boiled with 50 per cent. sulphuric acid, being reconverted into ketopininc acid.

When cautiously fused with caustic soda, or even when boiled with an alcoholic solution of sodium ethylate, ketopininc acid is converted into a dibasic acid, *Pinophanic acid* of the formula $C_{10}H_{16}O_4$ (C = 60.14, 60.13; H = 7.86, 8.02; Ag in silver salt = 51.87, 52.03; Calc. C = 60.00; H = 8.00; Ag = 52.17). Pinophanic acid melts at 203° ; it is insoluble in benzene, light petroleum, and chloroform, moderately soluble in hot water and hot ethylic acetate, and readily soluble in alcohol, acetone, and ether. Like ketopininc acid, it does not combine with bromine.

Although but slowly attacked, ketopininc acid is oxidised by prolonged digestion with neutral potassium permanganate solution. The product appears to be identical in composition with Kipping's camphotricarboxylic acid and Marsh and Gardner's camphoic acid, but more closely resembles the latter.

These acids are now being fully investigated.

43. "A synthesis of citric acid." By W. T. Laurence, B.A., Ph.D.

Ethylic citrate was obtained synthetically by the condensation of ethylic bromacetate with ethylic oxalylacetate in the presence of zinc, as indicated by the following equations:—(1) $COOEt \cdot CH_2Br + COOEt : CH_2 \cdot CO \cdot COOEt + Zn = COOEt \cdot CH_2 \cdot C(OZnBr)(CH_2 \cdot COOEt) \cdot COOEt$; (2) $COOEt \cdot CH_2 \cdot C(OZnBr)(CH_2 \cdot COOEt) \cdot COOEt + H_2O = COOEt \cdot CH_2 \cdot C(OH)(CH_2 \cdot COOEt) \cdot COOEt + ZnO + HBr$. The yield of ethylic citrate is very poor, owing to other reactions proceeding simultaneously. To further confirm the formation of ethylic citrate, it was converted into the calcium salt of citric acid, and a substance obtained showing the characteristic properties of calcium citrate. The same salt was also obtained by heating the zinc compound formed in equation No. 1 with alcoholic potash and precipitating the calcium citrate from the hot solution.

The results were all confirmed by analysis. The above synthesis of citric acid seems to be of interest as being more direct and simple than the synthesis from sym. dichloroacetone or from ethyl γ -cyanacetoacetate.

ADDITIONS TO THE LIBRARY.

I. *Purchase.*

Hintze, Carl. Handbuch der Mineralogie. Zweiter band, Silicate und Titanate. Pp. x+1841, mit 632 abbildungen im text. Leipzig 1897.

Brauns, Reinhard. Chemische Mineralogie Pp. xiii+460, mit 32 abbildungen im text. Leipzig 1896.

Duclaux, E. Pasteur: Histoire d'un esprit. Pp. vii+400. Sceaux 1896.

Engel, R., et Moitessier, J. Traité Élémentaire de Chimie Biologique, Pathologique, et Clinique. Pp. vii+615, avec 102 figures intercalées dans le texte et 2 planches coloriées. Paris 1897.

Possetto, G. La Chimica del vino. Analisi, alterazioni, manipolazioni, adulterazioni. Pp. xvi+496. Torino 1896.

Register of the Associates and old Students of the Royal College of Chemistry, the Royal School of Mines and the Royal College of Science, with Historical Introduction and Biographical notices, and portraits of Past and Present Professors by T. G. Chambers. Pp. cxxii+231. London 1896.

II. *Donations.*

Arth. G. Recueil de Procédés de Dosage pour l'analyse des combustibles des minerais de fer, des fontes, des aciers, et des fers. Pp. iii+313. Paris 1897. Two copies. From the Publishers.

Fresenius' Quantitative Analysis. Vol II., part IV. Translated by C. E. Groves, F.R.S. London 1897. From the Publishers.

PASTEUR MEMORIAL LECTURE.

The Pasteur Memorial Lecture will be delivered by Professor Percy Frankland, Ph.D., F.R.S., at an extra meeting of the Society on Thursday, March 25th, at 8 p.m.

ANNIVERSARY MEETING.

The Anniversary Meeting will be held on Wednesday, March 31st, at 3 o'clock in the afternoon.

ANNIVERSARY DINNER.

It has been arranged that the Fellows of the Society and their friends shall dine together at the Criterion Restaurant on Wednesday, March 31st, at 7 p.m. The President, Mr. A. G. Vernon Harcourt, in the Chair. *The Secretaries will be glad to receive early notification from those Fellows who intend to be present.*

At the next Meeting, on Thursday, March 18th, the following Papers will be received. The authors of those marked with an asterisk have announced their intention of being present.

* "On the atomic weight of carbon." By Alexander Scott, M.A., D.Sc.

* "On a new series of mixed sulphates of the vitriol group." By Alexander Scott, M.A., D.Sc.

* "The action of alkyl haloids on aldoximes and ketoximes." By Wyndham R. Dunstan, F.R.S., and Ernest Goulding.

PROCEEDINGS

OF THE

CHEMICAL SOCIETY.

EDITED BY THE SECRETARIES.

No. 177.

Session 1896-7.

March 18th, 1897. Mr. A. G. Vernon Harcourt, President, in the Chair.

Messrs. H. P. Stevens, J. W. Walker, W. Arbuckle, N. T. M. Wilsmore, M. Wilderman, W. J. Pope, A. W. Crossley, H. R. Le Sueur, J. H. Miller, R. D. Littlefield, F. H. Neville, W. M. Heller, G. McGowan, C. M. Crossman, J. Holmes, and F. Southerden were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. Alfred Hunter Boylau, Ellerslie, Richmond Road, Ealing, W.; Henry Norris Davidge, 37, Duke Street, Grosvenor Square, W.; Charles Henry Field, The Elms, Green Street Green, Orpington; Thomas Girtin, B.A., 125A, Highbury New Park, N.; James Jones, 117, Old Christchurch Road, Bournemouth; Charles MacCulloch, 395, Collins Street, Melbourne; George Fowlie Merson, 65, Northumberland Street, Newcastle; Thomas Tickle, 4, Pakenham Street, W.C.

In accordance with the bye-laws, the following communication was read from the Chair:—

WE, the undersigned, beg to propose Prof. William Ramsay, Ph.D., F.R.S., as President of the Chemical Society in succession to Mr. A. Vernon Harcourt, M.A., M.D., D.C.L., F.R.S.:—

Baly, E. C. C.; Baker, C. F.; Burgess, Herbert E.; Blount, Bertram; Blundstone, Edward R.; Berncastle, Richard; Cassal, Charles E.; Chattaway, F. D.; Chapman, Alfred C.; Collie, J. Norman; Chorley, John C.; Coste, J. H.; Crossley, Arthur; Dufton, S. T.; Ekins, Arthur E.; Edwards, W. Buckland; Evans, R. C. T.; Elborne, William; Earl, Alfred; Elford, P.; Forster, M. O.; Graham, Edward; Grimwood, R.; Harley, Vaughan; Harvey, Sydney; Baker, Julian L.;

Floris, R. B. ; Jackman, E. J. ; Jones, Cecil ; Johnson, David ; Kipping, Stanley F. ; Kellas, Alex. M. ; Kingzett, C. T. ; Ling, A. ; Lapworth, A. ; Livingston, W. T. ; Littlefield, R. D. ; Routledge, R. ; Lamb, Edmund ; Moody, Gerald T. ; Bodmer, R. ; Moor, C. G. ; Millar, J. H. ; McCrae, J. ; Macdonald, G. ; Mills, Charles ; McGowan, Geo. ; Pope, W. J. ; Parry, Ernest J. ; Picton, Harold ; Plimpton, R. T. ; Richmond, H. Droop ; Simpson, Arthur M. ; Stevens, H. P. ; Travers, M. W. ; Le Sueur, H. R. ; Wade, John ; Wagner, W. G. ; Wilsmore, N. T. M. ; Walker, J. Wallace ; Sworn, Sydney A. ; Cornish, Vaughan ; Sykes, Walter J. ; Waterhouse, Robert ; Chattaway, William ; Priest, Martin ; Marsh, J. E. ; Muspratt, Edmund K. ; Mitchell, C. A. ; Muspratt, Sydney K. ; Adams, Arthur ; Marshall, Arthur ; Wilson, John ; Bone, W. A. ; Fisher, E. H. ; Chapman, Arthur J. ; Wheelwright, E. W. ; Lewis, W. H. ; Sudborough, J. J. ; Velej, V. H. ; Walker, James ; Colman, Harold, G. ; Christopher, George ; Macnair, D. S. ; Bell, Chichester A. ; Wertheimer, J. ; Hodgkin, John ; Archbutt, Leonard ; Muir, M. M. Pattison ; Shaw, G. E. ; Taylor, R. L. ; Colwell, J. Kear ; Cribb, Cecil H. ; Butterfield, W. J. Atkinson ; Hanes, Edgar S. : Sutherland, D. A. ; Teed, Frank L. ; Fulcher, L. W. ; Heller, W. M. ; Sandford, P. Gerald ; Snape, H. Lloyd ; Knight, J. B. ; Cooper, A. J. ; Adams, P. T. ; Adams, M. A. ; Eiloart, A. ; Corfield, W. H. ; Muter, J. ; Muter, A. H. M. ; Dodd, W. H. ; Koningh, L. de ; Mawer, W. F. ; Lascelles, P. B. ; Bruce, James ; Turpin, G. S.

PROFESSOR COLLIE stated that the nomination of Professor Ramsay had been made without his knowledge or his permission.

Of the following papers, those marked * were read.

***44. "On the atomic weight of carbon." By Alexander Scott,
M.A., D.Sc.**

The object of this paper is to call attention to the unsatisfactory nature of the experimental evidence on which the determinations of the atomic weight of carbon rest. The two methods on which reliance is chiefly placed are shown to be only in agreement because a source of error which affects both acts in opposite directions. This is due to an erroneous determination of Dumas and Stas, in 1840, of the expansion produced in potash solutions by the absorption of carbon dioxide. All later workers at this problem seem to have accepted their conclusions without further verification. The seriousness of this source of error is apparent when we consider that over 40 milligrams is the correction for the weight *in vacuo* of the carbon dioxide in one experiment

alone. The correction per gram of carbon dioxide is shown to be 0.56 to 0.57 c.c., instead of 0.15 c.c., as taken by Dumas and Stas. The probable effect of the gases "occluded" in the copper oxide is next considered, and, as far as possible, allowed for. It is shown by many determinations that the experiments of Richards give the quantity as much too great, the mean result of his best experiments being 0.088 per cent. by weight of nitrogen in copper oxide made from the nitrate, whilst the experiments here described give as a mean only about 0.007 per cent.

Other sources of error and the best methods of making more accurate determinations are next considered. The recalculated values are 12.008 from the combustion of the various forms of carbon, and 12.050 from the conversion of the monoxide into the dioxide.

DISCUSSION.

In reply to questions from Mr. GROVES, Mr. BLOUNT, Mr. HEYCOCK, and the PRESIDENT, Dr. SCOTT stated that 150 grams of the oxalate furnished about 4 grams of carbon. In the case of the potash solution, it was the expansion of the liquid which had to be corrected for. The rate of absorption of carbon dioxide by potash solution at any given time was affected by the amount of carbon dioxide which had been already absorbed. Carbon monoxide was completely absorbed by potash after some time.

*45. "On a new series of mixed sulphates of the vitriol group."

By Alexander Scott, M.A., D.Sc.

This paper describes a new series of mixed sulphates of the form $(M,N)SO_4 \cdot H_2O$. The most interesting is the ferrous cupric sulphate, the colour of which is reddish-brown; it dissolves in water, giving a blue-green solution.

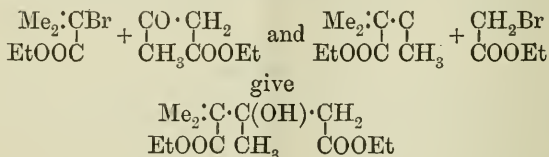
The composition of this salt on analysis corresponds to the formula $(CuFe)SO_4 \cdot H_2O$, or $(Fe_5Cu_2)(SO_4)_7 \cdot 7H_2O$. These salts are made by adding about an equal bulk of strong sulphuric acid to solutions of the mixed sulphates.

DISCUSSION.

Mr. SPILLER, referring to investigations he had conducted on some double sulphates of this group, crystallised from water, the results of which were communicated to the British Association ten years ago, said that he was led to the conclusion that the amount of water of crystallisation in such mixed sulphates was the mean of that present in their constituent salts.

*46. "A synthesis of camphoronic acid." By William Henry Perkin, jun., F.R.S., and Jocelyn Field Thorpe, Ph.D.

In a previous communication (Proc., 1896, 12, 155) experiments were described dealing with the action of metallic zinc on mixtures of bromo-ethylic salts and ketones or ketonic acids; notably on mixtures of ethylic aceto-acetate and ethylic α -brom-iso-butyrate, and of ethylic dimethylacetoacetate and ethylic bromoacetate, and it was shown that the same hydroxy-ethylic salt, namely, ethylic- β -hydroxy- α - β -trimethyl glutarate was in each case produced thus:



This *ethylic- β -hydroxy- α - β -trimethylglutarate* (b. p. 165° , 30 mm.), as previously stated, splits up, on hydrolysis with alcoholic potash, into acetic and isobutyric acids. When, however, it is boiled with dilute hydrochloric acid, it does not behave in this way, but yields considerable quantities of the corresponding *β -hydroxy- α - β -trimethylglutaric acid*, $\text{COOH}\cdot\text{C}(\text{CH}_3)_2\cdot\text{C}(\text{OH})\cdot(\text{CH}_3)\cdot\text{CH}_2\cdot\text{COOH}$, which is a crystalline body, separating from a mixture of light petroleum and ethylic acetate in glistening prisms melting at 128° .

In the previous communication, an acid melting at 148° , obtained by the action of alcoholic potassium cyanide on ethylic- β -brom- α - β -trimethyl glutarate, was described as a trimethylglutaric acid: we now wish to correct this statement. Alcoholic potassium cyanide is apparently without action upon the bromethylic salt at the temperature of the boiling water bath, and, on hydrolysing the product with alcoholic potassium hydroxide, the unsaturated acid, *α - β -trimethylglutaconic acid*, $\text{COOH}\cdot\text{CH}:\text{C}(\text{CH}_3)\cdot\text{C}(\text{CH}_3)_2\text{COOH}$, melting at 148° , is produced, and not the trimethylglutaric acid as was at first supposed. This acid is remarkably stable, and is not affected by boiling with sodium amalgam. When, however, its boiling solution in alcohol is treated with sodium, the unsaturated acid is gradually reduced to *α - β -trimethylglutaric acid*, $\text{COOH}\cdot\text{CH}_2\cdot\text{CH}(\text{CH}_3)\cdot\text{C}(\text{CH}_3)_2\cdot\text{COOH}$, which crystallises from dilute hydrochloric acid in prismatic needles melting at 109° ; the anhydride of this acid melts at 38° , and yields, on treatment with aniline, an *anilic acid* forming lustrous plates from dilute alcohol melting at 155° . Although the melting points of the acid and of the anil are very similar to those of the trimethylglutaric acid which Balbiano

obtained from camphoric acid, it does not appear that the acids are identical, and it is probable that Balbiano's acid is the isomeric α - β - β -trimethylglutaric acid, $\text{COOH} \cdot \text{CH}(\text{CH}_3) \cdot \text{C}(\text{CH}_3)_2 \cdot \text{CH}_2 \cdot \text{COOH}$, as this chemist suggests.

On treating ethylic β -hydroxy- α - α -trimethylglutarate with phosphorus pentachloride, the chlorethyl salt, namely, β -chlor- α - α -trimethyl glutarate, $\text{COOC}_2\text{H}_5\text{C}(\text{CH}_3)_2 \cdot \text{C}(\text{Cl}) \cdot (\text{CH}_3) \cdot \text{CH}_2 \cdot \text{COOC}_2\text{H}_5$, is obtained as a colourless, mobile liquid which boils at 139° (20 mm.). When this substance or the corresponding bromo-derivative is heated with alcoholic potassium cyanide in a closed tube at 160° ethylic β -cyano- α - α -trimethyl glutarate, $\text{COOEt} \cdot \text{C}(\text{Me}_2) \cdot \text{C}(\text{CN}) \cdot (\text{Me}) \cdot \text{CH}_2 \cdot \text{COOEt}$, is obtained after twelve hours as an oily liquid boiling at 180 — 185° (25 mm.). It is difficult to isolate in the pure condition owing to the presence of varying quantities of the ethylic salt of trimethylglutaconic acid, a substance which boils at about the same temperature as the nitrile (175° . 30 mm.).

This nitrile was hydrolysed by boiling with dilute hydrochloric acid, and after filtering from the trimethylglutaconic acid, which separated on cooling, the filtrate yielded on neutralisation with ammonia and addition of barium chloride no precipitate, but on boiling, a quantity of a sparingly soluble barium salt separated. This salt was collected, well washed, and decomposed by boiling with the calculated quantity of sulphuric acid; the filtrate from the barium sulphate was then evaporated to a small bulk, when on cooling a crystalline acid separated, which melted at 157° with decomposition, and on analysis gave the following numbers:—

0.1258 gram gave 0.2276 gram CO_2 and 0.0746 gram H_2O . Calc. for $(\text{C}_9\text{H}_{14}\text{O}_6)$: $\text{H} = 6.40$; $\text{C} = 49.50$. Found: $\text{H} = 6.58$; $\text{C} = 49.34$. α - α - β -trimethyltricarballic acid, $\text{COOH} \cdot \text{CH}_2\text{C}(\text{COOH})(\text{Me})\text{C}(\text{Me}_2)\text{COOH}$.

That this acid is identical with camphoronic acid is, in our opinion, proved by the following considerations:—

(1) The synthetical acid gives the same results on analysis, and melts at the same temperature as camphoronic acid.

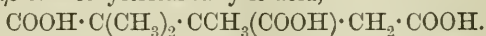
(2) When equal quantities of the synthetical acid and camphoronic acid are intimately mixed, the mixture melts at exactly the same temperature, i.e., 157° , with decomposition.

(3) It gives, when dissolved in a slight excess of ammonia, no precipitate with barium chloride until the liquid is warmed, and then the insoluble barium salt separates exactly as in the case of camphoronic acid.

(4) When heated with acetyl chloride, both the acids are converted into an anhydro-acid, which melts in both cases at 135 — 136° .

The anhydrocamphoronic acid from the synthetical acid gave on analysis the following results. Found, $\text{C} = 54.03$; $\text{H} = 6.11$. $\text{C}_9\text{H}_{12}\text{O}_5$. Calc. $\text{C} = 54.00$; $\text{H} = 6.00$ per cent.

In a previous communication (Proc., 1896, 12,²192),* one of us had occasion to express the opinion that Tiemann's formula for camphoronic acid, $\text{COOH} \cdot \text{CH}(\text{CH}_3) \cdot \text{C}(\text{CH}_3)_2 \cdot \text{CH} \cdot (\text{COOH})_2$, which contains the group $-\text{CH}(\text{COOH})_2$ must be incorrect, on account of the fact that camphoronic acid, when heated with water at 230° , is not decomposed with elimination of CO_2 . The experiments which we have briefly described in this communication appear to us to prove that camphoronic acid has the constitution first proposed by Bredt (*Ber.*, 1893, 26, 3048), namely, that of an $\alpha\alpha\beta$ -trimethyltricarballic acid,



47. "Note on a method for determining melting points." By Ernest H. Cook, D.Sc.

So many methods have been introduced for the determination of melting points, that an apology is perhaps necessary for describing another, but the following method has been found to work so well in this laboratory, and to be so easy of manipulation, that the author ventures to place it on record.

Notwithstanding, however, the theoretical simplicity of taking a melting point, it is surprising that in commercial work considerable differences frequently occur between analysts when reporting upon such a substance, for example, as paraffin scale. Probably most, if not all, of these differences are caused by the different methods employed. Thus it is well known that "the English test," which consists in allowing the wax to solidify in a test-tube in which the thermometer is placed gives results from $2\frac{1}{2}$ to 3 degrees Fahr. lower than the "American test," in which the wax is melted in an open dish. Both these methods again differ slightly from the capillary-tube plan, and in this process a different result is obtained when an open tube is used than when it is closed. There are in fact many precautions which are necessary to be observed if concordant results are to be obtained, and it is much to be desired that some distinct and definite regulations should be made with reference to the matter.

The apparatus employed is a beaker filled to the brim with water; inside this, and separated from it on all sides, is a smaller one. The smaller beaker is partly filled with mercury in which is placed a thermometer. A stirrer is used to keep the water in the large beaker of uniform temperature. A cardboard or other disc covers the smaller beaker when the operation is in progress. The whole is heated from below by means of a sand bath. When the melting point to be deter-

* The formula given here from Bredt's constitution of camphoronic acid is a misprint, it should be $\text{COOH} \cdot \text{C}(\text{CH}_3)_2 - \text{C}(\text{CH}_3)(\text{COOH}) - \text{CH}_2 \cdot \text{COOH}$.

mined is under 30° it is better to replace the sand bath by an evaporating dish containing water.

The process is conducted as follows. The material whose melting point is to be taken is placed on three or four small pieces of thin ferro-type plate or other thin metallic sheet, or on the cover glasses which are used for microscope slides. If ferro-type or other metallic slips are used, care must be taken to remove the varnish or other coating in order that good metallic contact can be had with the mercury. The slips, with the substance on them, are now placed on the surface of the mercury and the heat applied until the substance melts. The solidifying point is obtained by raising the temperature above the melting point and allowing the beaker to cool, noting the thermometer when the first solidification takes place.

For temperatures between 100° and 200° , the larger beaker is filled with paraffin wax.

The following precautions have been found to be necessary:—(1) The temperature must be made to rise very slowly. (2) The liquid in the outer beaker must be frequently stirred. (3) Not less than 2.5 cm. in depth of mercury must cover the inner beaker. (4) Sufficient volume of water must be allowed between the two beakers. The minimum distances to give good results are 1 in. between them laterally and $1\frac{1}{2}$ inch at the bottom. (5) The inner beaker must be immersed a sufficient depth in the water. This point is of great importance, the least distance between the top of the mercury and the top of the water being 3 inches. A greater distance is, however, to be preferred. (6) The whole apparatus should be protected from draughts. (7) The disc should be kept on the smaller beaker during the determination.

The following examples will show the degree of accuracy to be obtained in ordinary working, some of the results being obtained by students who have never taken a melting point determination before. Paraffin wax (1), 49.8, 49.7, 49.5, 49.8. Paraffin wax (2), 46.2, 46.0, 46.0, 46.0. Paraffin wax (3), 46.5, 46.3, 46.5. Ortho-mono-nitro-phenol 44.5, 44.7. Urea, 131.0, 131.5, 131.2.

48. "Velocity of urea formation in aqueous alcohol." By James Walker, D.Sc., and Sydney A. Kay, B.Sc.

The authors have investigated the rate of formation of urea from ammonium cyanate in pure water, and in mixtures of water and alcohol containing 10, 30, 50, 70, and 90 per cent. by volume of the latter. The alcohol acts in two ways: first, it diminishes the degree of dissociation of the cyanate and thus retards the action by diminishing the number of active molecules; secondly, it increases the rate at which the ions produced by the dissociation interact. The

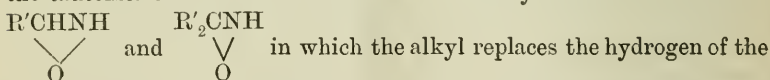
second mode of action outweighs the first, so that there is on the whole a marked acceleration as the water of the solvent is replaced by alcohol. If the reverse transformation of urea into cyanate, and the degree of dissociation of the latter at the various stages of the process, are taken into consideration, the requirements of the law of mass-action are strictly fulfilled.

Methylic alcohol, acetone, glycol, glycerol, and cane-sugar exert a similar accelerating effect when part of the water used as solvent is replaced by them.

From the displacement of the point of equilibrium between cyanate and urea by change of temperature, it is calculated that the transformation of ammonium ions and cyanic ions into urea is accompanied by a heat evolution of about 5,000 cal. per gram-molecule.

49. "Action of alkyl haloids on aldoximes and ketoximes." By Wyndham R. Dunstan, F.R.S., and Ernest Goulding.

The authors find that, when formaldoxime, acetaldoxime, and acetoxime are heated in alcoholic solution with an alkyl iodide or bromide, they are converted into compounds of alkyloximes in which the alkyl group is united to nitrogen $R'CHN(R')O$ and $R'_2CNCH(R')O$. These derivatives are isomerides of the little known ethers of the oximes $R'CH : NOR'$ and R'_2CNOR' , and are to be regarded as derivatives of the tautomeric or isoximido-forms of the ordinary aldoxime or ketoxime



in which the alkyl replaces the hydrogen of the amido-group. Their constitution has been proved by their hydrolysis into β -substituted hydroxylamines, $NH(R')OH$, and the corresponding aldehyde or ketone.

Formaldoxime, when mixed with methyl iodide, either in alcoholic or ethereal solution, is converted into a crystalline salt of the formula $(CH_2NOH)_3CH_3I$. It has been previously shown (Dunstan and Bossi, Proc., 1894, 10, 55) that formaldoxime forms salts with monobasic acids which contain three molecules of the oxime, $(CH_2NOH)_3HCl$, &c. On hydrolysis, followed by reduction, one molecule of methylamine hydrochloride and two of ammonium chloride are produced, and on heating near its melting point (102°) only two molecules of formaldoxime distil from it. The formula of the compound may therefore be written $(CH_2NOH)_2, CH_2N(CH_3)O.HI$. The base corresponding with this salt could not be separated. Methyl bromide heated with formaldoxime furnishes the corresponding hydrobromide.

Acetaldoxime combines with methyl iodide, forming the hydriodide of a base which has so far only been obtained in the liquid state even

after a process of fractional precipitation of an alcoholic solution by ether. On hydrolysis, this salt furnishes acetaldehyde and β -methylhydroxylamine. There can, therefore, be no doubt that its formula is $\text{CH}_3\text{CHN}(\text{CH}_3)\text{O.HI}$. Methyl bromide combines in the same manner, forming the corresponding hydrobromide. Ethyl iodide forms the hydriodide of the ethyl derivative, $\text{CH}_3\text{CHN}(\text{C}_2\text{H}_5)\text{O.HI}$. Neither of the salts has been crystallised and the corresponding bases are highly unstable.

Acetoxime.—By heating acetoxime with methyl iodide, a red liquid is obtained which, on concentration, deposits red crystals with a fine green lustre. The mother liquor furnished the little-known *methylamine hydriodide* ($\text{CH}_3\text{NH}_2.\text{HI}$) in glistening, crystalline plates (from alcohol and ether). This is a very stable non-deliquescent salt, melting at 220° with partial decomposition.

The red crystals were proved by analysis to be a methylacetoxime periodide of the formula $[(\text{CH}_3)_2\text{CN}(\text{CH}_3)\text{O.HI}]_2\text{I}$. On hydrolysis, it breaks up into acetone and β -methylhydroxylamine.

Many attempts were made to isolate the hydriodide from the periodide, and also to prepare other salts from this compound, including the base, but without success, owing to the great instability of these substances.

The hydrobromide appears to be formed when methyl bromide is heated with an alcoholic solution of acetoxime, but this salt could not be crystallised.

PASTEUR MEMORIAL LECTURE.

The Pasteur Memorial Lecture will be delivered by Professor Percy Frankland, Ph.D., F.R.S., at an extra meeting of the Society on Thursday, March 25th, at 8 p.m.

ANNIVERSARY MEETING.

The Anniversary Meeting will be held on Wednesday, March 31st, at 3 o'clock in the afternoon.

ANNIVERSARY DINNER.

It has been arranged that the Fellows of the Society and their friends shall dine together at the Criterion Restaurant on Wednesday, March 31st, at 7 p.m. The President, Mr. A. G. Vernon Harcourt, in

the Chair. *The Secretaries will be glad to receive notification from those Fellows who intend to be present before Friday, March 26th, so that the final arrangements may be completed.*

At the Meeting on April 1st, the following Paper will be received. The authors have announced their intention of being present.

“On the oxidation of α - γ -dimethyl- α' -chloropyridine.” By E. Aston and J. Norman Collie, Ph.D., F.R.S.

PROCEEDINGS
OF THE
CHEMICAL SOCIETY.
EDITED BY THE SECRETARIES.

No. 178.

Session 1896-7.

March 25th, 1897. Extra Meeting. MR. A. G. VERNON HARCOURT President, in the chair.

Professor P. FRANKLAND, Ph.D., B.Sc., F.R.S., delivered the Pasteur Memorial Lecture.

It was pointed out that, although the name of Pasteur was associated with the progress of so many branches of science, it appeared that his remarkable success in such varied fields of investigation was in large measure due to the chemical discipline under which he had grown up, and in his having almost for the first time extended the experimental methods and close reasoning of the chemist to other sciences, in which previous investigators had been mostly occupied with matters of a superficial character. Reference was then made to Pasteur's birth, on December 27, 1822, his early life and entrance as a student into the *École Normale*, to his being retained as an assistant there by Balard, and to his interest being awakened in the study of crystallography by Delafosse. His classical researches on the tartrates and malates were then described, and the principal results discussed from a practical and theoretical point of view. It was shown of what enormous importance for the development of chemical theory had been the introduction by Pasteur of the conception of molecular symmetry and dissymmetry, whilst the wide applicability of his methods of investigating stereoisomeric compounds was indicated in outline. The manner in which he was next led to investigate fermentation phenomena was then described, his conflict with Liebig was touched upon, and his overthrow of the so-called 'chemical fermentation theory' detailed. Reference was then made to his participation in the spontaneous generation controversy, and to his victories over Pouchet, Joly, Musset, and Bastian, the last champions of the doctrine of abiogenesis. The practical aspects of Pasteur's fermentation studies

were briefly considered, the famous 'Études sur la bière'; 'sur le vin,' and 'sur le vinaigre,' as well as process known as *pasteurisation*. The direct influence of these fermentation studies on medicine, surgery, and public health was pointed out, and the manner in which they had led to the magnificent work of Lister on the antiseptic treatment of wounds was indicated. Pasteur's investigation of the destructive silkworm diseases, *pébrine* and *flacherie*, was then dealt with, and his gradual attraction into the field of pathological research traced. His studies on anthrax, his recognition of the bacillus of malignant œdema, and his discovery of the *staphylococcus pyogenes* and of the *streptococcus pyogenes* were referred to. Then the manner in which he came upon the possibility of attenuating viruses and preparing vaccines was described; the lecture concluding with an account of the methods of protective inoculation devised by Pasteur, first for fowl-cholera, then for anthrax, for swine-measles, and his final triumph in successfully elaborating a curative treatment for rabies.

LORD LISTER, P.R.S., proposed, and Sir HENRY ROSCOE seconded, a vote of thanks to Professor PERCY FRANKLAND, which was carried unanimously.

March 31st, 1896. Anniversary Meeting. Mr. A. G. Vernon Harcourt, President, in the Chair.

Professor COLLIE, F.R.S., and Dr. WYNNE, F.R.S., were appointed Scrutators, and a ballot was opened for the election of Officers and Council for the ensuing year, the ballot being closed at the conclusion of the President's address.

The Longstaff Medal was then presented to Professor RAMSAY for the discovery of helium, and for his share in the investigation of argon. The PRESIDENT referred to the circumstances under which the first announcement of the discovery was made, and expressed the pleasure he felt in presenting him with the Medal.

The PRESIDENT began his address by thanking the Fellows, and more especially the Officers and Council, for the kindness with which they had aided him during his year of office, and expressed his pleasure at the progress of the Society during the past year. He referred to the arrangements made for the reading of papers, and suggested means by which the discussions might be made more useful.

The publication of the Jubilee volume, largely drawn up by Dr. Armstrong, was mentioned, and the services rendered by Mr. Warrington

in its preparation were acknowledged. The Hofmann Memorial Lectures had also been issued. Lothar Meyer and Pasteur Memorial Lectures had been delivered in the year, and arrangements had been made for the Kekulé Lecture. Reference was also made to the work of the Council through the year, to the death of Sir William Grove, an original member of the Society, and to the munificent donation of one thousand guineas by Mr. J. J. Tustin.

The remainder of the address was devoted to a consideration of the question whether the changes which matter undergoes are different in their nature.

The numerical strength of the Society was as follows :—

Number of Fellows, March 31st, 1896	2,019
„ „ since elected	130
„ „ reinstated by Council	7

2,156

Removed on account of non-payment of two

annual subscriptions	25
Withdrawn	29
Deaths	23

77

Number of Fellows, March 31st, 1897	2,079
Foreign Members	27

The names of those removed were :—P. T. Adams ; Hugh Barclay ; Thos. Cockerill ; Thos. Chambers ; S. M. Copeman ; C. A. Heywood ; John Holliday ; A. P. Hope ; J. J. Howitt ; J. R. Kaye ; L. R. Lenox ; O. A. B. Lowman ; J. G. Mactaggart ; H. J. Monson ; F. C. Moorwood ; Percy Morton ; Ivan Shopoff ; E. H. Smith ; T. B. Stillman ; C. A. Stitt ; Prof. Tanner ; G. de R. Thompson ; F. W. Westaway ; W. A. Whiston ; D. Wilkinson.

The following have withdrawn :—F. T. Bond ; T. Coomber ; C. L. Field ; A. E. Fletcher ; C. C. Grundy ; E. C. Henning ; G. S. Johnson ; W. H. Joseland ; C. J. Leaper ; J. H. Maiden ; J. W. Marshall ; John Morrison ; H. W. Morrow ; J. A. Nettleton ; J. C. Oman ; C. S. du R. Preller ; Lawrence Priestley ; H. H. Robjohns ; H. C. Sacré ; W. S. Saunders ; V. P. Sells ; R. de F. Shepherd ; R. Stockdale ; Frederick Tetley ; J. C. Thresh ; A. H. Turton ; Geo. Watson ; F. Whiteley ; C. Willmore.

The following have died :—I. M. T. Anderson ; John Curragh ; Captain Marshall Hall ; G. Harley, F.R.S. ; James Hart ; John Hughes ; W. Lapraik, Ph.D. ; J. B. L. Mackay ; A. H. Mason ; H. A. Nott ; Baron F. von Mueller, F.R.S. ; W. J. Palmer ; Sir J.

Prestwich, F.R.S. ; Edward Rawlins ; G. F. Schacht ; James Scorgie ; T. Shimidzu ; T. J. Smith ; Charles Tomlinson, F.R.S. ; W. H. Walenn ; Richard Weaver ; W. H. Wood ; T. G. Wormley, M.D.

The number of communications made to the Society during the year was 173.

One hundred and seventeen papers and 3 Memorial Lectures were published in the Transactions for 1896, occupying 1702 pages, whereas in the preceding year 116 papers were published, occupying 1172 pages.

The following were the statistics relating to the Abstracts.

PART I.		
	Pages.	No. of Abstracts.
Organic Chemistry	716	1201
PART II.		
General and Physical Chemistry		319
Inorganic Chemistry		287
Mineralogical Chemistry.....		267
Physiological Chemistry.....		182
Chemistry of Vegetable Physiology and Agri- culture		153
Analytical Chemistry		430
Total in Part II	684	1638
Total in Parts I and II	1400	2839

Eight hundred and fifteen volumes had been borrowed from, and 163 books, 310 volumes of periodicals, and 24 pamphlets added to the Library.

Professor ODLING, F.R.S., proposed a vote of thanks to the President, coupled with the request that he would allow his address to be printed in the Transactions.

Dr. FRANKLAND, F.R.S., seconded the motion, which was carried by acclamation.

The PRESIDENT having returned thanks,

Dr. THORPE, F.R.S., the treasurer, gave an account of the balance sheet, which he laid before the Society, duly audited.

The receipts had been :—By admission fees and subscriptions, £4134 ; by sale of Journal and advertisements, £702 14s. 9d. ; and by dividends on invested capital, £415 10s. 6d. The expenses had been :—On account of the Journal, £3089 8s. 1d. ; on account of the

Proceedings, £237 18s. 1d.; on account of the General Index, £464 3s. 9d.; on account of the Library, £355 2s. 0d.; on account of the Jubilee, £336 12s. 1d.; House expenses £199 17s. 4d.; the total expenditure being £5385 4s. 7d. Grants amounting to £308 had been made to Fellows from the Research Fund during the year.

Sir F. ABEL, F.R.S., proposed that the thanks of the Fellows be tendered to the Treasurer for his services during the past year; this motion was seconded by Mr. PHIPSON BEALE, Q.C., and carried.

The TREASURER, in responding, proposed a vote of thanks to the auditors.

Mr. J. H. M. PAGE seconded the motion, which was unanimously adopted, and acknowledged by Mr. H. B. BAKER.

Dr. W. J. RUSSELL, F.R.S., proposed a vote of thanks to the Officers and Council.

Professor TILDEN, F.R.S., seconded the motion, which was unanimously adopted.

Dr. DYER responded on behalf of the Council.

Professor H. B. DIXON, F.R.S., proposed a vote of thanks to the Editor, Sub-Editor, Abstractors, and Indexers, which was seconded by Mr. FRISWELL and carried.

Mr. GROVES, F.R.S., responded.

The Scrutators having presented their report to the President, he declared that the following had been duly elected:—

President: James Dewar, M.A., LL.D., F.R.S.

Vice-Presidents who have filled the office of President: Sir F. A. Abel, Bart., K.C.B., D.C.L., F.R.S.; H. E. Armstrong, Ph.D., LL.D., F.R.S.; A. Crum Brown, D.Sc., M.D., F.R.S.; W. Crookes, F.R.S.; E. Frankland, D.C.L., F.R.S.; Sir J. H. Gilbert, Ph.D., F.R.S.; J. H. Gladstone, Ph.D., F.R.S.; A. Vernon Harcourt, D.C.L., F.R.S.; H. Müller, Ph.D., F.R.S.; W. Odling, M.B., F.R.S.; W. H. Perkin, LL.D., Ph.D., F.R.S.; Lord Playfair, Ph.D., K.C.B., F.R.S.; Sir H. E. Roscoe, LL.D., F.R.S.; W. J. Russell, Ph.D., F.R.S.; A. W. Williamson, LL.D., F.R.S.

Vice-Presidents: Francis Robert Japp, M.A., Ph.D., LL.D., F.R.S.; Ludwig Mond, F.R.S.; William Ramsay, Ph.D., F.R.S.; J. Emerson Reynolds, D.Sc., F.R.S.; W. Chandler Roberts-Austen, C.B., F.R.S.; William A. Tilden, F.R.S.

Secretaries: J. Millar Thomson; Wyndham R. Dunstan, M.A., F.R.S.

Foreign Secretary: Raphael Meldola, F.R.S.

Treasurer: T. E. Thorpe, LL.D., F.R.S.

Other Members of Council: P. Phillips Bedson, D.Sc.; Bennett Hooper Brough; Otto Hehner; C. T. Heycock, M.A., F.R.S.;

Herbert McLeod, F.R.S. ; Rudolph Messel, Ph.D. ; H. Forster Morley, M.A. ; James Wyllie Rodger ; T. Kirke Rose, D.Sc. ; Alexander Scott, M.A., D.Sc. ; Arthur Smithells, B.Sc. ; Sydney Young, D.Sc., F.R.S.

The question having been raised as to whether the number of votes cast for each candidate for the Presidency should be declared, the PRESIDENT stated that this had not been the custom, but he would take the sense of the meeting on the point. A majority being in favour of a declaration of the numbers, the PRESIDENT conferred with the Scrutators and then stated that there was a difficulty in announcing the numbers, owing to a question having arisen in reference to the validity of certain voting papers, in which the instruction to erase the printed name had not been complied with.

Inasmuch as the rejection of these irregular papers would only increase the majority and not affect the result of the election, and as it now appeared that the announcement of the numbers would involve recounting the votes, the PRESIDENT suggested that the Fellows should be content with the Scrutators' report. The ruling of the President as to the validity of the irregular papers having been requested, he stated that, in his opinion, they were invalid.

Questions having been asked as to the bye-laws governing the election, the PRESIDENT stated that the election had been conducted in strict accordance with the bye-laws, and he therefore declared the election valid.

In the evening, at 7 p.m., the Fellows and their friends dined together at the Criterion Restaurant, Mr. A. G. Vernon Harcourt, the retiring President, in the Chair.

The following Fellows and guests were present.

Alexander, Mr.	Candy, Mr.
Armstrong, Dr., F.R.S.	Carr, Mr. F. H.
Atkinson, Dr. E.	Carteighe, Mr.
Barlet, Mr.	Chattaway, Dr.
Bauerman, Mr. H.	Chevalier, R.N., Com.
Bayly, Mr.	Christie, Mr., F.R.S., <i>Astronomer Royal</i> .
Bevan, Mr. E. J.	Clerk, Mr. Dugald
Bidwell, Mr. Shelford, F.R.S., <i>President</i>	Clowes, Prof.
<i>of the Physical Society.</i>	Cooper, Mr. A. B.
Blundstone, Mr.	Cooper, Mr.
Blundstone, Mr. S. R.	Cowper-Coles, Mr.
Brough, Mr.	Crookes, Mr. W., F.R.S.
Brown, Mr. H., F.R.S.	Crookes, Mr. H.
Burbidge, Mr.	Cross, Mr. C. F.
Butterfield, Mr.	Crossley, Dr.

Daoust, Mr.
 Dewar, Prof., F.R.S. (*President Elect*).
 Dixon, Prof., F.R.S.
 Dodds, Mr. J. M.
 Douglas, Mr. W.
 Dunstan, Prof., F.R.S., *Hon. Secretary*.
 Dyer, Dr. B., *President of the Society of Public Analysts*.

Elder, Mr. H. M., *Secretary of the Physical Society*.

Evans, Mr. R. C.
 Evans, Sir John, K.C.B., *Treas. R.S.*
 Ewan, Dr.

Fairley, Mr. T.
 Fenton, Mr.
 Fitzroy, Col.
 Formoy, Mr.
 Forster, Dr.
 Foster, Prof. G. C., F.R.S.
 Foster, Prof. M., *Secretary R.S.*

Gardiner, Dr. H. S.
 Gladstone, Dr., F.R.S.
 Goodwin, Mr. H. B.
 Griffiths, Mr. E. H., F.R.S.
 Gordon, Mr. J. G.
 Greenaway, Mr.
 Groves, Mr., F.R.S.

Hall, Mr. S.
 Hall, Mr. S. G.
 Hammick, Mr. J. F.
 Harcourt, Mr. A. G. V., F.R.S.
 Hare, Mr. A. T.
 Harvey, Dr.
 Hehner, Mr.
 Heycock, Mr. C. T., F.R.S.
 Hicks, Dr., F.R.S., *President of the Geological Society*.
 Hills, Capt., R.E.
 Hills, Mr. W., *Pres. of the Pharm. Soc.*
 Howard, Mr. D. Lloyd.
 Huntington, Prof.
 Huntly, Mr. G. N.

Jackson, Mr. H.
 Jenks, Mr. R. L.
 Jones, Mr. G. F.

Kellner, Dr.
 Kemp, Mr. W. J.

Kirkaldy, Mr.
 Knowles, Mr. J.

Lawson, Dr.
 Lister, Lord, P.R.S.
 Lloyd, Gen., C.B.

MacEwan, Mr.
 MacMahon, Major, R.A., F.R.S.
 Mallet, Mr. F. R.

Martin, Mr. W. H.
 Martindale, Mr.
 Messel, Dr., *Chairman of the London Section Society Chemical Industry*.
 Masters, Mr. W.
 Matthey, Mr. E.
 McLeod, Prof., F.R.S.
 Meldola, Prof., F.R.S., *Foreign Secretary*.
 Moody, Dr.
 Morris, Dr. G. H.
 Morrison, Mr. C. R.
 Mortimer, Capt.
 Moss, Mr. R. J.
 Moulton, Mr. Fletcher, Q.C., F.R.S.
 Müller, Dr. H., F.R.S.

Nagel, Mr.
 Neville, Mr.

Obach, Dr.
 Odling, Prof., F.R.S.
 Orange, Dr., C.B.
 Ormsby, Col., R.A.

Page, Mr.
 Pearce, Mr.
 Perkin, Dr., F.R.S., *Master of the Leather-sellers' Company*.
 Ping, Mr.
 Pope, Dr.
 Power, Dr. F. B.
 Pritchard, Prof.

Rée, Dr.
 Reynolds, Prof. Emerson, F.R.S.
 Robbins, Mr.
 Roberts-Austen, Prof., C.B., F.R.S.
 Rose, Dr.
 Rosenblum, Mr.
 Rücker, Prof., F.R.S., *Sec. R.S.*
 Russell, Dr. W. J., F.R.S.

Scott, Dr.	Thorpe, Prof., F.R.S., <i>Treasurer.</i>
Seaton, Dr.	Tilden, Prof., F.R.S.,
Siemens, Mr. A.	Tooke, Mr.
Slater, Mr.	Turner, Mr.
Spooner, Mr. F. B.	Tutton, Mr.
Sprengel, Prof., F.R.S.	
Steele, Mr. R., <i>Assistant Secretary and Librarian.</i>	Vautin, Mr.
Stevenson, Dr., <i>President Institute of Chemistry.</i>	Voelcker, Dr. J. A.
Sudlow, Mr.	
Sutherland, Mr. D. A.	Wade, Mr. J.
	Wellcome, Mr. H. S.
	Whitaker, Mr., F.R.S.
Taubman, Mr. R.	Williamson, Dr. S.
Thomson, Prof. J. M., <i>Honorary Secretary.</i>	Wynne, Dr., F.R.S.

The following toasts were proposed.

By the Chairman.

1. Her Most Gracious Majesty the Queen.
2. Their Royal Highnesses the Prince and Princess of Wales and the other members of the Royal Family.

By the Right Hon. Lord Lister, President of the Royal Society.

3. Prosperity to the Chemical Society.

By William Crookes, Esq., F.R.S.

4. The Learned and Scientific Societies, coupled with the name of Sir John Evans, K.C.B., Treasurer of the Royal Society.

By Dr. J. H. Gladstone, F.R.S.

5. The Guests, coupled with the name of Professor Michael Foster, Secretary of the Royal Society.

By Dr. W. J. Russell, F.R.S.

6. The retiring President.

By Dr. Armstrong, F.R.S.

7. The Secretaries, coupled with the name of Professor J. M. Thomson.
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April 1st, 1897. Professor Dewar, F.R.S., President, in the Chair.

Messrs. William Douglas, Ernest Goulding, T. H. Lee and W. A. Davis were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. William Barlow, Hillfield, Muswell Hill, N.; James Brierley, 12 Brunswick Square, Southampton; Alexander Duckham, Crooms Hill, Greenwich Park, S.E.; Harold William Harrie, 298 Amhurst Road, Stoke Newington, N.; Sydney Hill, 11 Salisbury Street, Hull; Willie Lee Mallinson, Gawthorp Green, Kirkheaton; Edmund Howd Miller, M.A., Ph.D., Columbia University, U.S.A.; Joseph Previte Kennedy Orton, B.A., Ph.D., 20 Loughborough Road, Brixton, S.W.; Charles Alfred West, 105 Sydney Street, Chelsea, S.W.; Paul Thomas White, Horton Field, West Drayton.

Mr. CASSAL asked whether the President would take steps to carry into effect the wishes of a majority at the Anniversary Meeting, that a recount of the ballot papers should be made, and the votes recorded for the two nominees for the Presidency announced to the Fellows.

Mr. VERNON HARCOURT said that, although a majority at the Anniversary Meeting had declared themselves in favour of the announcement of the numbers, it had not been found possible to make any exact announcement without going through the voting papers again, and he had hoped that, having regard to all the circumstances, it would be generally felt best to accept the result of the election as it had been recorded by the Scrutators, especially as a succinct and accurate account of what had happened at the Anniversary Meeting had been included in the minutes.

The PRESIDENT said he considered the subject closed, but promised to bring the question before the Council. He could not see that any good would result from a recount of the voting papers for the mere purpose of declaring the exact numerical majority by which the President had been elected. He hoped that long before the Council met the matter would be forgotten.

Of the following papers those marked * were read.

*50. "The hydrolysis of perthiocyanic acid." By F. D. Chattaway, M.A., and H. P. Stevens, B.A.

When potassium thiocyanate is treated with sulphuric acid, many different substances are produced; thiocyanic acid, however, is always first liberated, and then reacts in various ways determined by the conditions of the experiment.

The best known reaction, usually represented as a simple hydrolysis of thiocyanic acid, is that by which carbon oxysulphide is commonly

prepared. Other actions, however, go on, and the carbon oxysulphide is invariably mixed with carbon dioxide, sulphur dioxide, hydrocyanic acid, and carbon bisulphide.

The authors have observed that, in addition to these, a considerable amount of thiourea is produced. This thiourea has been found to be a decomposition product of perthiocyanic acid, which is always formed in considerable quantity when acids act upon thiocyanates, and the paper deals mainly with the hydrolysis of this acid.

Perthiocyanic acid is easily hydrolysed, either by heating with water under pressure, or by heating with strong sulphuric acid, thiourea, carbon oxysulphide, and sulphur being formed. $\text{H}_2\text{N}_2\text{C}_2\text{S}_3 + \text{H}_2\text{O} = \text{CS}(\text{NH}_2)_2 + \text{COS} + \text{S}$. As the action only takes place at a comparatively high temperature, one or other of these products is invariably decomposed. When perthiocyanic acid is heated with water to about 200° in closed tubes, this action may be considered to take place first, but at the high temperature the thiourea is transformed completely into ammonium thiocyanate, while the carbon oxysulphide reacts with water, giving carbon dioxide and hydrogen sulphide so that the final action is $\text{H}_2\text{N}_2\text{C}_2\text{S}_3 + 2\text{H}_2\text{O} = \text{NH}_4\text{NCS} + \text{CO}_2 + \text{H}_2\text{S} + \text{S}$.

When perthiocyanic acid is heated with 60 per cent. sulphuric acid, a similar hydrolysis must also take place; a certain amount of the thiourea, however, escapes transformation, but the sulphur and carbon oxysulphide are oxidised by the sulphuric acid, sulphur dioxide and carbon dioxide being produced.

The thiourea found among the products of the action of strong sulphuric acid on potassium thiocyanate, is, without doubt, formed in this way by the action of the strong acid on the perthiocyanic acid first produced.

DISCUSSION.

In reply to questions from Mr. GROVES and the PRESIDENT, Mr. STEVENS stated that they had not been able to analyse the liquid supposed to be hydrogen disulphide, but they were satisfied as to its identity from a comparison of its properties with those of hydrogen disulphide specially prepared for the purpose.

*51. "The composition of cooked fish." By Katharine I. Williams.

Twenty-two species of fresh fish and five species of preserved fish and oysters were examined after cooking.

Determinations were made of the following constituents: water; carbon and hydrogen; nitrogen (total) by Ruffle's method; nitrogen by soda lime combustion; ash; sulphur; phosphorus; fat; proteids; carbohydrates convertible into glucose; nitrates extracted by dilute alcohol; heats of combustion. The results are recorded in a series of tables.

DISCUSSION.

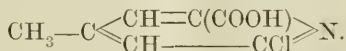
In reply to questions from Mr. GROVES, Mr. HEHNER, Mr. SUTHERLAND, Mr. CASSAL, and Professor DUNSTAN, Miss WILLIAMS stated that the fish, in each case, had been analysed in the condition in which it would be eaten. Details of the mode in which the fish had been prepared were given in the paper. The common opinion that fish contained much phosphorus seemed to be erroneous. Little or none of the phosphorus would be removed in cooking.

*52. "On the oxidation products of $\alpha\gamma$ -dimethyl- α' -chloropyridine."

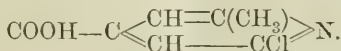
By Emily Aston, B.Sc., and J. Norman Collie, Ph.D., F.R.S.

The present communication is an account of the continuation of some work of one of the authors with A. P. Sedgwick (Trans., 1895, 67, 399). The substance $\alpha\gamma$ -dimethyl- α' -chloropyridine was obtained by the action of phosphorus pentachloride on pseudolutidostyryl. When oxidised with potassium permanganate, two isomeric acids are obtained, each having the formula $C_5H_2(CH_3)(COOH)NCl$. One (m. p. 98°) is much more soluble in water than the other and crystallises with 1 mol. of water; it produces with ferrous sulphate an orange-brown coloration. When strongly heated, it decomposes with much charring and evolution of carbon dioxide and some hydrogen chloride; the residue furnished α -chloro- γ -methylpyridine, $C_5H_3(CH_3)NCl$, b. p. 194° . Prolonged treatment with tin and hydrochloric acid gave γ -methylpicolinic acid, and this substance when distilled yielded picoline or γ -methylpyridine.

This acid (m. p. 98°) is, therefore, α -chloro- γ -methyl- α' -pyridine carboxylic acid.



The second acid obtained by the action of potassium permanganate on $\alpha\gamma$ -dimethyl- α' -chloropyridine is much less soluble in water. It melts at 214° , and on heating completely decomposes without forming chloropicoline. With ferrous sulphate, it furnished a precipitate instead of a coloration. Tin and hydrochloric acid only reduced it very slowly, and it was found to be impossible to separate the chlorine free acid from the unchanged compound. A small quantity of free α -picoline was, however, obtained by distilling the impure reduced acid, thus proving that this acid (m. p. 214°) was the α -chloro- α -methyl- α' -pyridine carboxylic acid.



Attempts were made to obtain the dicarboxylic acid from both the acids by oxidising with potassium permanganate, but without success.

ADDITIONS TO THE LIBRARY.

Donations.

Cohn, Georg. Tabellarische übersicht der Pyrazolderivate. Pp. 443. Braunschweig 1897. From the Publishers.

Bailey, G. H. First stage Inorganic Chemistry. Pp. viii + 210. London 1897. Edited by W. Briggs, M.A. From the Editor.

Dolbear, A. E. First Principles of Natural Philosophy. Pp. ix + 318. London 1897. From the Publishers.

Jones, Chapman. A Course of Elementary Experiments for Students of Practical Inorganic Chemistry. Pp. xii + 161. London 1897. From the Author.

Ricketts, P. de P., and Miller, E. H. Notes on Assaying, 1st Ed. Pp. viii + 311. New York 1897. From the Publishers.

Pamphlets.

Smith, H. G. On the Constituents of the Sap of the "Silky Oak," *Grevillea robusta*, R.Br., and the Presence of Butyric Acid therein. (Read before the Royal Society of N. S. Wales, October 7, 1896).

Smith, H. G. The dyeing properties of aromadendrin and of the tannins of *Eucalyptus kinos*. (Reprinted from the Journal of the Society of Chemical Industry.)

At the next Meeting, on Thursday, April 29th, the following papers will be received.

"Monochlordiparaconic acid and some condensations." By H. C. Myers, Ph.D.

"On the decomposition of iron pyrites." By W. A. Caldecott, B.A.

At the Meeting on Thursday, May 6th, there will be a ballot for the election of Fellows, and the following Papers will be received. The authors of those marked with an asterisk have announced their intention of being present.

* "A bunsen burner for acetylene." By A. E. Munby, M.A.

* "On the reactions between lead and the oxides of sulphur." By H. C. Jenkins and E. A. Smith.

CERTIFICATES OF CANDIDATES FOR ELECTION.

N.B.—The names of those who sign from “General Knowledge” are printed in *italics*.

The following have been proposed for election. A ballot will be held on Thursday, May 6th, 1897.

Barlow, Herbert William Leyland.

Holly Bank, Urmston, Manchester.

At present engaged in Research. M.A., M.B., Oxon. Formerly Natural Science Scholar, Trinity College, Oxford. First-class Honours in Chemistry, 1889. Junior Demonstrator, Balliol College Laboratory, 1890. Second-class Physiology, 1891. Price Scholar, London Hospital, 1894.

John Conroy.

D. H. Nagel.

A. Vernon Harcourt.

W. W. Fisher.

V. H. Veley.

Barlow, William,

Hillfield, Muswell Hill, N.

Fellow of the Geological and Mineralogical Societies. Has published a number of papers on geological and crystallographical subjects. Is at present engaged in studying the chemical aspects of the theory of crystalline structure.

Henry E. Armstrong.

Gerald T. Moody.

F. Stanley Kipping.

William J. Pope.

Sidney Williamson.

Boylan, Alfred Hunter,

“Ellerslie,” Richmond Road, Ealing, W.

Analytical Chemist and Bacteriologist. Attended Professor Ramsay's course of lectures on Chemistry for 2 years at University College. With J. Parry Laws, Esq., F.I.C., $4\frac{1}{2}$ years, 3 years as Articled Pupil, and subsequently as Assistant, assisting him in his investigations for the London County Council. Nine months chemist to the British Gas Light Co., Ltd., at their Norwich and Yarmouth Works, and for several months engaged by the Sulphide Corporation to assist in per-

fecting a process for the treatment of sulphide ores, assisting in the chemical and bacteriological work of the special enquiry made by the London County Council into the London Water Supply.

J. Parry Laws.

W. Ramsay.

W. J. Dibdin.

J. H. Coste.

Wm. Chattaway.

Brierley, James,

12, Brunswick Square, Southampton.

Public Analyst, Consulting and Analytical Chemist. Consulting Chemist to the Corporation of Southampton and Public Analyst for the Borough. Late Lecturer on Chemistry and Physics at the Hartley Institution, Southampton (23 years). Member of the Society of Public Analysts.

Percy F. Frankland.

J. Lane Notter.

J. Theo. Hewitt.

H. Wilson.

Otto Hehner.

Bernard Dyer.

Davidge, Henry Norris,

37, Duke Street, Grosvenor Square, W.

Pharmaceutical Chemist. Member of the Pharmaceutical Society, (Major Examination).

M. Carteighe.

W. Watson Will.

W. Chas. Sayers.

J. L. Bullock.

Hubert E. Lindley.

James Bayne.

Wm. Harkness.

Deverell, Louis Charles,

Onslow House, Worthing, Sussex.

Analytical Chemist. Trained in Chemistry at the Camborne School of Mines, Cornwall; for the last thirteen months (and at present) assistant to Mr. B. Kitto, F.I.C., 30 and 31, St. Swithin's Lane, E.C.

George T. Holloway.

W. J. Cousins.

Cecil H. Cribb.

J. J. Beringer.

W. T. Burgess.

Bernard Dyer.

Duckham, Alexander,

Crooms Hill, Greenwich Park, S.E.

Student of Chemistry. I have studied Physics for 2, and Chemistry for 3, years at University College, London. Awarded Gold Medal for Inorganic Chemistry, and Clothworkers' Exhibition.

William Ramsay.

J. Norman Collie.

A. G. Bloxam.

John Shields.

Edward C. Cyril Baly.

Morris W. Travers.

J. Wallace Walker.

N. T. M. Wilshire.

Alex. M. Kellas.

Fenby, Alaric Vincent Colpoys,

Hutton Grammar School, Preston.

Science Master. Junior Demonstrator in Physics, Mason College, Session 1889—90. Tutor in Chemistry, University Examination, Postal Institution, London, March—Sept., 1893. Lecturer on Chemistry, Walsall Institute, Sept.—Dec., 1893. Science Master at Hutton Grammar School, Preston, since Sept., 1894. Student of the Mason Science College, Birmingham, 1888—1892, chiefly in Chemistry and Physics. Elected an Associate of Mason College, March, 1892. B.Sc., London University, University Scholar in Chemistry, 1891; with Second Class Honours in Physics at Intermediate Science Examination, 1889.

William A. Tilden.

W. W. J. Nicol.

Thomas Turner.

T. Rhymer Marshall.

Harold G. Colman.

Field, Charles Henry,

The Elms, Green St. Green, Orpington, Kent.

Brewer. Studed Chemistry at the University Colleges, Nottingham and London. Also in Germany. Passed the Examination of the Institute of Chemistry.

Frank Clowes.

J. Bernard Coleman.

R. Lloyd Whiteley.

L. Archbutt.

J. J. Sudborough.

F. J. R. Carulla.

Girtin, Thomas,

125A, Highbury New Park, London, N.

nt. B.A., Pembroke College, Cambridge. Chemistry Special First Class in Parts I and II. Student of Metallurgy and Assaying with Mr. F. Claudet.

W. J. Sell.

S. Ruhemann.

M. M. Pattison Muir.

H. J. H. Fenton.

A. Hutchinson.

Arthur J. Chapman.

Guyer, R. Glode,

20, Queen's Road, St. John's Wood.

Pharmaceutical Chemist. Laboratory Chemist to Messrs. Hodgkinson, Trimber and Clarke, Manufacturing Chemists and Druggists. Studied Chemistry under Professors Attfield and Dunstan, at the Pharmaceutical Society's School, Bloomsbury; also Organic Chemistry, Practical and Theoretical, at the Finsbury Technical College, under Professor Meldola. Have been continuously engaged in Laboratory work for the past 7 years.

M. Carteighe.

John Attfield.

J. H. Gladstone.

Wyndham R. Dunstan.

R. Meldola.

H. A. D. Jowett.

Harrie, Harold William,

298, Amhurst Road, Stoke Newington, N.

Senior Assistant in Chemical Laboratory. For 10 years engaged in the Chemical Laboratory of Messrs. Harker, Stagg and Morgan, London. From 4 to 5 years Student in the Chemical Laboratory of the City of London College. Holder of several Certificates in Inorganic and Organic Chemistry at Kensington.

Isaac S. Scarf.

E. J. Jackman.

L. W. Hawkins.

Bernard Dyer.

Horace V. Buttfeld.

Thos. Tyrer.

J. H. Coste.

Richard J. Moss.

Hill, Sydney,

11, Salisbury Street, Hull.

Analytical and Technical Chemist with Blundell, Spence and Co., Limited, Hull and London, Paint, Colour, Oil, and Varnish Manufacturers. Appointed to present post in 1891. Pupil for 3 years, 1888—90, of G. Carr-Robinson, F.R.S.E., F.I.C., F.C.S., Consulting Chemist, Professor of Practical Chemistry and Lecturer at the Royal Institution Laboratory, Hull. Passed examination in Honours Practical Chemistry, also other examinations.

C. C. Graham.

M. D. Penney.

Jas. Baynes.

G. Carr-Robinson.

Fredk. Johnson.

Allan T. Hall.

Jones, James,

117, Old Christchurch Road, Bournemouth.

Analytical Chemist. Private Research. Desirous of keeping abreast of recent chemical discoveries.

H. Wilson.

Frank H. Alcock.

Chas. Umney.

William Fowler.

Arthur P. Luff.

Peter MacEwan.

W. B. Randall.

Lasseter, William James George,

10, Stanley Road, Oxford.

Science Master, Roysser School, Abingdon. Formerly Science Master, Henley Grammar School. Graduate in Honours, Nat. Science, Oxford University. Scientific Lecturer to Abingdon Town Council.

W. W. Fisher.

John Watts.

J. E. Marsh.

V. H. Veley.

Wm. Odling.

J. A. Gardner.

MacCulloch, Charles,

395, Collins Street, Melbourne, Australia.

Metallurgist. Three years in the Chemical Laboratory at Glasgow University. Employed in construction and management of Chlorination Works at Cassilis, Gippsland, treating refractory ores. At present engaged in Metallurgical research work in my private laboratory.

C. M. Aikman.

Hamilton M. Wingate.

J. Holms Pollok.

Thomas Gray.

Matthew A. Parker.

Mallinson, Willie Lee,

Gawthorp Green, Kirkheaton, nr. Huddersfield.

Manufacturing Chemist. Student at Huddersfield College, afterwards two and a half years assistant to Mr. George Jarman, F.I.C., Public Analyst for the Borough of Huddersfield.

Lewis S. Cocking.

Joe Frost.

James Sykes.

L. Gordon Paul.

Hy. Ellison, Jr.

Merson, George Fowlie,

55, Northumberland Street, Newcastle-on-Tyne.

Pharmaceutical Chemist. The applicant has passed all the examinations of the Pharmaceutical Society of Great Britain, and has for several years been, and now is, Principal of the North of England School of Pharmacy, in which capacity he lectures on Chemistry and collateral Branches of Science. For several years he was Analytical Chemist on the staff of Mawson, Swan and Weddell, Newcastle-on-Tyne, Manufacturing Chemists, being Laboratory Superintendent.

M. Conroy.

John Fleet.

C. Ranken.

Chas. Edward Sage.

Peter MacEwan.

William Duncan.

John Pattinson.

John C. Umney.

Chas. Umney.

Wm. Martindale.

J. Wilson Swan.

Miller, Edmund Howd,

Columbia University.

Teacher of Chemistry. Graduate of School of Mines in course of Analytical and Applied Chemistry in 1891. Master of Arts, 1892. Doctor of Philosophy, 1894. Author of "Assay of Tin," *School of Mines Quarterly*, vol. xiii, No. 4, and *Journal of Analytical and Applied Chemistry*, 1892; "Succinimid," *Journal American Chemical Society*, July, 1894; "Assay of Platinum," *School of Mines Quarterly*, vol. xvii, No. 1; "Notes on the Assay of Rich Silver Ores," *School of*

Mines Quarterly, vol. xvii, No. 2; "Notes on Ferrocyanides of Zinc and Manganese," *Journal American Chemical Society*, December, 1896; *Notes on Assaying* (with P. de P. Ricketts), Wiley and Sons, New York, 1896.

C. F. Chandler.

Jas. S. C. Wells.

H. T. Vulte.

S. A. Goldschmidt.

Arthur H. Elliott.

Mitchell, Tom,

Cemetery House, Shaw, nr. Oldham.

Analytical Chemist. For three years a Student in the evening Classes of the Chemical Dept., Owens College, 1892—95. For one year assisted in Gas Analysis in the Research Laboratory, Owens Coll., 1895—6. Has practised as an Analytical Chemist for two years.

H. B. Dixon.

W. H. Perkin, Jr.

Bevan Lean.

G. H. Bailey.

Wm. A. Bone.

De Morgan, Frederick Filmer,

Andely Lodge, Caeran Park, Newport (Mon.).

Student. Passed Intermediate Science, London. Studied Chemistry at the University College of South Wales and Monmouthshire, Cardiff, during the Sessions 1891—92, 1892—93, 1893—94. Passed Major Examination of the Pharmaceutical Society. Student for one year with W. Watson Will, Esq., 1895—6. Worked for four months in the laboratory of the Tharsis Copper and Sulphur Co., Cardiff (Sept., 1894—Jan., 1895). At present studying at King's College for B.Sc., London.

Claude M. Thompson.

E. P. Perman

John M. Thomson.

Herbert Jackson.

Patrick H. Kirkaldy.

W. Watson Will.

William H. Sodeau.

Orton, Kennedy Joseph Previte,

20, Loughborough Road, Brixton, S.W.

Hutchinson Research Student of St. John's Coll., Cambridge (in Chemistry). B.A., Cambridge. Ph.D., Heidelberg. Author of (1), with Dr. S. Ruhemann, "Studien in der Pyridin-Reihe, ein Beitrag zur Configuration der Aconitsäure," *Berlin Berichte*, 27, 3449; (2), with Dr. S. Ruhemann, "Studies in the Malonic Acid Series," *Trans. of the Chem. Society* (1895), p. 1002; (3), with Professor Auwers, "Kryoskopische Untersuchungen," *Zeitschrift. f. physikalische Chemie*, 21, 337.

William Ramsay.

M. M. Pattison Muir.

Alex. M. Kellas.

M. W. Travers.

N. T. M. Wilsmore.

G. Nevill Huntly.

John Shields.

Edward C. Cyril Baly.

Phillips, Harry Edward William,
47, Chalfont Road, Oxford.

Science Lecturer to Oxford County Council, Oxford High School, City Technical School, and Diocesan Training College. B.A. (Oxon.), Honours in Chemistry, 1895. Now engaged in research work in Chemical Laboratory, Oxford University.

Wm. Odling.

W. W. Fisher.

V. H. Veley.

J. E. Marsh.

John Watts.

A. E. Tutton.

J. A. Gardner.

Pickard, Robert Howson,

Southfield, Priory Road, Edgbaston, Birmingham.

Student in the University at Munich. London Bachelor of Science Degree (1st Class Honours in Chemistry), "1851 Exhibition" Scholar. Joint Author with Prof. P. F. Frankland, F.R.S., of "Rotation of Optically Active Compounds in Organic Solvents" (published in Trans., 1896).

Percy F. Frankland.

Charles Frederic Baker.

William A. Tilden.

Walter G. McMillan.

Chas. Hunt.

Tickle, Thomas,

4, Pakenham Street, London, W.C.

Salters' Research Fellow in Chemistry at the Laboratory of the Pharmaceutical Society. Work connected with a paper "The Action of Methyl Alcohol on Aconitine, by Wyndham R. Dunstan, F.R.S., Thomas Tickle, and D. H. Jackson, Ph.D.," read before the Chemical Society, June 18th, 1896. Formerly Demonstrator in Practical Chemistry in the Pharmaceutical Society's Laboratory.

J. Norman Collie.

Wyndham R. Dunstan.

M. Carteighe.

Harry Carter Draper.

Arthur Lapworth.

Waite, William Herbert,

Park Road, Halifax.

Science Master at Penketh School. B.A. Cantab.

W. J. Sell.

S. Ruhemann.

R. Haliburton Adie.

H. J. H. Fenton.

S. Skinner.

M. M. Pattison Muir.

Watts, Charles Thomas Foster,

7, Cambrian Crescent, Chester.

Tutor. Science Teacher at Chester School of Science since 1893. Now responsible for Chemical Laboratory and Day Classes in Chemistry.

Science and Art Department Certificates, including First Honours in Practical Chemistry, and about 12 Advanced Certificates. London University Intermediate B.Sc., First Division.

Philip Schidrowitz.

John Bairstow.

W. F. Lowe.

W. B. Hards.

William Briggs.

Welsh, John,

12A, Seller Street, Chester.

Pharmaceutical Chemist. Have done a good deal of private work in the Laboratory of Chester Science School, besides having attended several full courses in Chemistry, Practical and Theoretical, Organic and Inorganic, in the above School, and also in Botany, Physics, Magnetism, and Electrical Chemistry, &c., in Liverpool School of Pharmacy. Hold Minor and Major Certificates of Pharmaceutical Society, of which Society I am a member. Hold Certificates in Advanced Stages of Inorganic Chemistry, First Practical and Second Theoretical; also First Advanced Botany in South Kensington Examinations. Have taken Honours Course, Practical Inorganic Chemistry, South Kensington Syllabus, at Chester School of Science Laboratory.

John Bairstow.

Philip Schidrowitz.

W. F. Lowe.

Otto Rosenheim.

Michael Conroy.

West, Charles Alfred,

105, Sydney Street, Chelsea, S.W.

Science Teacher. Associate of the City of London College, 1894. National Scholar for Chemistry and Physics, 1st place 1894, 1894—97. Student at the Royal College of Science under Professor Tilden. Demonstrator and Lecturer in Physics at the City of London College, 1894—97.

William A. Tilden.

W. Palmer Wynne.

Chapman Jones.

John A. Craw.

Isaac S. Scarf.

White, Paul Thomas,

Horton Field, West Drayton, Middlesex, and Castle Street, Saffron Hill, E.C.

Member of the firm of Alfred White and Sons, Manufacturing Chemists. Son of the late Mr. Alfred White, F.S.A., F.L.S., &c., who was also a Fellow of the Chemical Society from 1851 to his death, on March 8th, 1895.

George Matthey.

David Howard.

Bernard Dyer.

Rudolph Messel.

B. E. R. Newlands.

Wm. Macnab.

Wm. Newlands.

PROCEEDINGS
OF THE
CHEMICAL SOCIETY.

EDITED BY THE SECRETARIES.

No. 179.

Session 1896-7.

April 29th, 1897. Professor Dewar, F.R.S., President, in the Chair.

Messrs. Arthur Croft Hill, Edward G. Guest, and Horatio Ballantyne were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. Gerald Noel Brown, 8, The Esplanade, Plymouth; George Lawson Johnston, Kingswood, Sydenham Hill, S.E.; William Taverner, 1, Stapenhill Road, Burton-on-Trent.

The PRESIDENT announced that the Council had ordered a recount of the balloting papers handed in at the Anniversary Meeting. The recount would be conducted by the two Scrutators appointed by the Society at the Anniversary Meeting, in the presence of the Secretaries.

Mr. CASSAL enquired whether the actual numbers would be announced. The PRESIDENT replied that he assumed that they would.

Of the following papers, those marked * were read:—

- *53. "On the explosion of chlorine peroxide with carbonic oxide."
By H. B. Dixon, M.A., F.R.S., and E. J. Russell, B.Sc.

To test the question whether dried carbonic oxide is more readily attacked by 'nascent' than by ordinary oxygen, the authors have fired a dried mixture of chlorine peroxide and carbonic oxide. They find that the carbonic oxide is not completely burnt in the flame although the oxygen is in excess; and the drier the mixture the less carbonic oxide appears to be burnt. The results do not favour the view that 'nascent' oxygen attacks carbonic oxide more readily than ordinary oxygen.

DISCUSSION.

Dr. SCOTT thought it desirable to try the effect of some compound, such as chloride monoxide, which contained only one atom of oxygen, before concluding that 'nascent' oxygen was inoperative.

Professor ARMSTRONG referred to the difficulty of ascertaining whether a gas was completely free from water.

The PRESIDENT thought that the ultra-violet spectrum of water vapour, which he and Professor Liveing and Dr. Huggins had simultaneously discovered, would be found to be a very delicate test of its presence in flames or explosive mixtures.

Mr. CROOKES agreed with the President as to the delicacy of this test.

***54. "On the decomposition of iron pyrites." By W. A. Caldecott, B.A.**

In Watt's Dictionary (1892 edition, vol. iii, page 64) it is stated that ferrous sulphide "is formed by the reduction of Fe_2O_3 on ferric salts by decomposing organic matter in the presence of sulphates," also that "finely divided yellow pyrites (FeS_2) oxidises in air forming chiefly FeSO_4 ." T. K. Rose (*The Metallurgy of Gold*, 1896, page 343) states that " FeS_2 is oxidised by air and water, FeSO_4 and free H_2SO_4 being formed."

In the treatment of auriferous pyritic Witwatersrand conglomerate, a large percentage of the ore is reduced by wet crushing in the battery to an impalpable powder. This fine material constitutes "slimes," and is carried in suspension by water into extensive dams, where it settles. The slimes leaving the battery are free from ferrous sulphide, but this compound may be detected in them a few days after deposition in the dams. The settled slimes form a clayey mass, practically impermeable to air and water, and consequently subsequent oxidation of the ferrous sulphide to ferrous sulphate proceeds extremely slowly.

When iron pyrites are crushed to an impalpable powder in an iron mortar ferrous sulphide is formed.

It thus appears that ferrous sulphide and not ferrous sulphate may be the first product of the decomposition of iron pyrites.

Owing to the almost total absence of acidity in slimes deposited as above, even when containing 0.89 per cent. ferrous sulphide, it is probable that under these conditions FeS_2 undergoes dissociation, and the sulphur is separated as such; the author is engaged in further investigating this subject.

***55. "Monochlordiparaconic acid and some condensations." By Henry C. Myers, Ph.D.**

An attempt to prepare methylparaconic acid by the reduction of the trichlor-acid furnished the dichlor-acid, which on treatment with

barium-hydroxide suffered condensation, forming the acid $C_9H_9ClO_2$, which has been called monochlordiparaconic acid; its constitution is under investigation. This acid loses its chlorine on treatment with nascent hydrogen, producing a compound having in all probability the formula $C_9H_{12}O_2$, but it is so unstable that its investigation is very difficult. These condensations are being further investigated.

56. "Corydaline. Part V." By James J. Dobbie, M.A., D.Sc., and Fred Marsden, M.Sc., Ph.D.

When corydaline is heated on the water bath with very dilute nitric acid (about 1:20), a difficultly soluble nitrate, $C_{22}H_{25}NO_4 \cdot HNO_3$, is first formed.

On further heating, the solution becomes dark red in colour, and soon ceases to give any precipitate on testing with ammonia. If at this stage the solution be allowed to cool, groups of bright yellow prismatic crystals separate out on the sides of the vessel. The crystals consist of the nitrate of a base—dehydrocorydaline—differing from corydaline by four atoms of hydrogen (*cf.* Trans., 1897, 72, i, 175). The free base is very soluble in water and alcohol, and is difficult to obtain in crystals. The nitrate, $C_{22}H_{25}NO_4 \cdot HNO_3$, the chloride $C_{22}H_{25}NO_4 \cdot HCl$, the platinochloride $(C_{22}H_{25}NO_4 \cdot HCl)_2PtCl_4$, and the chloroform compound, $C_{22}H_{25}NO_4 \cdot CHCl_3$, are described. The solutions of dehydrocorydaline and its salts have an intense yellow colour, and give a vivid green colour with blue litmus. Reducing agents reconvert dehydrocorydaline into optically inactive corydaline.

If concentration of the acid solution be continued beyond the point at which dehydrocorydaline is formed until platinum chloride no longer gives a precipitate, yellow coloured crystals of an acid melting at 218° separate out on cooling. This acid, to which, for convenience of reference, the name *corydic* is temporarily given, is readily soluble in hot water and in alcohol, but insoluble in ether. Its aqueous solution has an intense yellow colour, and does not give precipitates with any of the metals in aqueous solution.

A silver salt, $C_{18}H_{15}NO_6Ag_2$, is obtained by precipitating an alcoholic solution of the potassium salt of the acid with an alcoholic solution of silver nitrate. Corydic acid contains two methoxy-groups and is dibasic. Its formula is $C_{14}H_9N(OCH_3)_2(COOH)_2, \frac{1}{2}H_2O$. When heated with hydrogen iodide, it yields a highly insoluble phenolic acid, $C_{14}H_9N(OH)_2(CO \cdot OH)_2 \cdot 2H_2O$, which separates from a large quantity of hot water in brilliant yellow spangles. The lead salt of this derivative, dried at 130° , has the composition $C_{16}H_{11}NO_6 \cdot Pb$.

When corydic acid is boiled with a solution of potassium permanganate, it yields a mixture of at least four acids.

(1) An acid, $C_{12}H_6N(OCH_3)_2(CO_2H)_3$, which crystallises from hot water in small, white, acicular crystals melting at 228° . This acid, which is the chief product of the oxidation, contains two methoxy-groups. A silver salt having the composition $C_{17}H_{12}NO_8Ag_3$ has been prepared. (2) A hemipinic acid, yielding an ethylimide which melts at 228° , and differs therefore from the hemipinic acid previously described as occurring amongst the products of oxidation of corydaline with potassium permanganate. It is thus established that corydaline contains two benzene nuclei, and the formation of corydic acid from the alkaloid is easily explained on the assumption that one of the rings is oxidised. (3) A nitrogenous acid melting at 208° which contains no methoxy-groups and gives a faint brownish-yellow colour with ferrous sulphate solution, and evolves a strong odour of pyridine when heated with lime. This acid has the formula $C_9H_7NO_6 \cdot H_2O$, and is apparently a methylpyridine tricarboxylic acid. It is not identical with any of the known acids of this composition. It forms a silver salt, $C_9H_4NO_6Ag_3$, and gives precipitates with lead, barium, and copper. (4) A nitrogenous acid melting at 243° , which gives a yellowish-red colour with ferrous sulphate and contains methoxyl.

Oxalic acid and the nitrogenous acid melting at 208° were obtained from the mother liquors of corydic acid.

May 6th, 1897. Professor Dewar, F.R.S., President, in the Chair.

Certificates were read for the first time in favour of Messrs. William Ackroyd, 9, Grandsmere Place, Halifax; William Malam Brothers, Beechwood House, Prestwich, near Manchester; William Cranfield, 5, Second Avenue, Halifax; A. F. Bilderbeck Gomez, 24A, Alfred Place West, South Kensington; Frederick Roscoe Grundy, B.Sc., 20, Derby Road, Douglas, Isle of Man; Edward Halliwell, Alexandra Crescent, Dewsbury; Harold Harman, Brewers Sugar Co., Greenock; William Robertson Pollock, Kirkland, Bonhill, Dumbarton.

The PRESIDENT stated that, in accordance with the instructions of the Council, the two Scrutators, in the presence of the Secretaries, had recounted the votes recorded for the Presidency at the Anniversary Meeting. The Scrutators' report would be presented to the Council in due course, but he thought he might now venture to say that he learned from the Senior Secretary that the votes accepted by the Scrutators were 166 for the Council's nominee, and 152 against.

The following were duly elected, Fellows of the Society. Messrs. Herbert W. L. Barlow, M.A., M.B.; William Barlow; Alfred Hunter Boylan; James Brierley; Henry Norris Davidge; Louis Charles Deverell; Alexander Duckham; Alaric Vincent C. Fenby, B.Sc.; Charles Henry Field; Thomas Girtin, B.A.; R. Glode Guyer; Harold

William Harrie; Sydney Hill; W. J. G. Lasseter, M.A.; Charles Macculloch; Willie Lee Mallinson; George Fowlie Merson; Edmund Howd Miller, M.A., Ph.D.; Tom Mitchell; Frederick Filmer de Morgan; Joseph Previte K. Orton, B.A., Ph.D.; Harry E. W. Phillips, B.A.; Robert Howson Pickard, B.Sc.; Thomas Tickle; William Herbert Waite, B.A.; Charles Thomas Foster Watts; John Welsh; Charles Alfred West; Paul Thomas White.

Of the following papers, those marked * were read.

***57. "A Bunsen burner for acetylene." By A. E. Munby, M.A.**

The cheap production of calcium carbide has placed a powerful illuminant within the reach of those who possess no gas supply, but so far little has been heard of the use of acetylene as a heating agent. Our laboratory is, as far as we know, the first to make use of the gas for this purpose. We employ a bunsen burner of special dimensions, the tube being five millimetres in internal diameter. A slightly wider tube may be used, provided the mouth be curved inwards, so that the actual exit does not exceed the diameter mentioned; if larger, the flame tends to strike down. The gas jet is very small, being only capable of delivering about one cubic foot of acetylene per hour under six inches water pressure, such a rate of consumption giving an ordinary working flame. The air holes and collar are arranged as in an ordinary bunsen, the exact size of the former not being of much importance provided they be large enough to admit the air required. The burner is protected with a cap, when not in use, as its efficiency depends upon the jet maintaining its dimensions. A generator capable of giving gas under seven inches water pressure with the full number of burners in use is required. Under this pressure a large, perfectly blue flame is obtained, which may be turned down to what may be termed a quarter bunsen flame, equivalent to burning the gas under three to four inches water pressure. This is the smallest pressure with which the burner will give a non-luminous flame; when turned lower, the zone of partial combustion appears, since the draught is then insufficient.

The heating effect of the flame is of course very great, enabling one to dispense with the blow-pipe for some operations, such as small fusions. From a few experiments on heating equal quantities of water under like conditions with coal gas and acetylene, it would seem that in practice, for equal volumes burnt, the latter has nearly twice the heating power of the former.

The use of the gas should do much to stimulate research in country places and on private estates.

*58. "The reactions between lead and the oxides of sulphur."
By Henry C. Jenkins and Ernest A. Smith.

The authors draw attention to the fact mentioned by one of them during the discussion on Mr. Hannay's paper (Proc., 1894, 10, 113, 151,) that when lead is heated to high temperatures and a current of sulphur dioxide passed through it, lead sulphide and oxide are formed. They have conducted experiments with a view to see whether the observations accounted for the anomalies hitherto met with whenever a full explanation of the chemistry of lead smelting in the reverberatory furnace has been attempted. Mr. Hannay had sought to explain these anomalies by the assumption that a volatile compound, PbS_2O_2 , was formed, basing his evidence on an observation that in some experiments of his where air was passed over heated galena, he only obtained one-half of the lead in the metallic state. He gave the equation $2\text{PbS} + \text{O}_2 = \text{Pb} + \text{PbS}_2\text{O}_2$ as representing what occurred. The experiments have been carefully repeated by the authors, who find that the ratio of lead obtained to lead volatilised is not constant but varies, and is entirely dependent on the velocity of the current of air, indicating that no such reaction exists and that the ratio found in Mr. Hannay's experiments was the result of the accidental coincidence of his experimental conditions.

The authors, on continuing the experiments, found on heating lead sulphide and lead sulphate in a vacuum, that a reaction having sulphur dioxide as a product occurred, and they found that the amount of residual lead sulphide and oxide was dependent on the duration as well as on the temperature of the experiment. They then proceeded to separately test the pairs of bodies supposed to be present, with a view to discover if secondary or reversed reaction occurred. On heating lead and lead sulphate, they always obtained lead sulphide in the product in amounts varying with the duration of the experiment and the length of time that it occupied.

On heating lead and sulphur dioxide together, they found that at moderately elevated temperatures lead sulphide and sulphuric anhydride are formed in each other's presence, and that this leads to the formation, first of lead oxide and then of lead sulphate, the action being represented more or less completely by the equations $\text{Pb} + 3\text{SO}_2 = \text{PbS} + 2\text{SO}_3$, $\text{Pb} + 2\text{SO}_3 = \text{PbSO}_4 + \text{SO}_2$, or more simply, $2\text{Pb} + 2\text{SO}_2 = \text{PbS} + \text{PbSO}_4$, the main determining condition as to the relative amount of the products being that of the temperature at which the experiment is performed. One of the authors is continuing the investigation of the exact condition of the equilibrium.

The last of these equations occurring in the presence of excess of

sulphur dioxide, is the exact inverse of the main ones of the metallurgy of lead as stated by Dr. Percy, and requires a supply of air by which to sweep away the sulphur dioxide as soon as it is liberated. The authors submit that, as the new equations quite account for the anomalies to which attention has been drawn, there is now no reason whatever to doubt that the equations given by Dr. Percy, $\text{Pb} + \text{PbSO}_4 = 2\text{PbO} + \text{SO}_2$, $\text{PbS} + \text{PbSO}_4 = 2\text{Pb} + 2\text{SO}_2$, as well as $\text{PbS} + 2\text{PbO} = 3\text{Pb} + \text{SO}_2$, represent the facts and form the basis of the metallurgy of lead.

DISCUSSION.

Professor ROBERTS-AUSTEN said that he was much gratified by the fact that the accuracy of the time-honoured equations given by his distinguished predecessor, Dr. Percy, as representing the metallurgy of lead, had been abundantly justified by work done in the Metallurgical Laboratory of the Royal College of Science. He could testify to the extreme care which Messrs. Jenkins and Smith had given to the work, and the reversible reactions they had discovered were not only very interesting, but of much industrial importance. In justice to Mr. Hannay, it might be conceded that the singular nature of the reactions discovered by the authors of the paper justified Mr. Hannay in questioning the accuracy of the old equations, and it was satisfactory that the difficulty had now been solved.

The PRESIDENT, Mr. GROVES, and Professor ARMSTRONG thought the author's experiments showed that it was unnecessary to suppose that any new compound of lead and sulphur was concerned in the metallurgical process.

*59. "X Ray photographs of solid alloys." By C. T. Heycock, F.R.S., and F. H. Neville.

In a previous communication (*Trans.*, 1889, 55, 666), we discussed the behaviour of gold in sodium and the state of the gold in the solid alloy. We have lately examined alloys of gold and sodium by cutting thin sections from cylinders of the alloy of various concentrations, placing these on a photographic plate, and photographing them by means of the X rays.

On account of the much greater transparency of sodium to these rays as compared with gold, the individual crystals of the alloy are clearly shown. The plates were about 12 mm. thick, and the alloy had been allowed to cool and solidify very slowly. Pure sodium shows no crystalline structure, but an alloy containing 3 per cent. of gold shows a mass of transparent sodium crystals, with dark spaces between the crystals where the gold has concentrated during the process of solidification.

A 10 per cent. alloy of gold shows the same phenomena, but the crystals of sodium are narrower, and the dark spaces occupy a larger area.

The appearance of the sodium crystals strongly recalls the fern-like pattern seen when ammonia chloride is crystallised on a microscopic plate, doubtless due to the fact that sodium, like so many other metals, crystallises in the regular system. An eutectic alloy of gold and sodium (23.1 per cent. gold) shows, as one would expect, scarcely any structure, because the crystals of gold and sodium separate out simultaneously, and are too minute to be detected by such a method.

A solution obtained by saturating sodium with gold at a temperature considerably above the melting point of sodium shows a net-work of black, opaque needles, which are no doubt crystals of gold which have separated and grown to a considerable size as the liquid cooled.

No sodium crystals are here visible, as the groundwork consisted of the eutectic alloy. We have been able to demonstrate the internal structure of a solid alloy, and to show that the process of solidification is strictly comparable to that of a saline solution, the details being perfectly visible to the naked eye.

We have already examined some aluminium alloys by this method, and hope to present a complete account of the work to the Society. The method will probably be applicable in all cases where there is a considerable difference in transparency between the metals of an alloy.

DISCUSSION.

Professor ROBERTS-AUSTEN said that the use of Röntgen rays for revealing the structure of certain alloys possessed advantages when it was desirable to view the alloys as transparent, as distinguished from the structure shown by a section in a single plane. The structure of alloys as revealed by microphotography had now attained great perfection, notably in the hands of M. Osmond in France, and it was a subject to which Professor Austen had recently given much attention; but the X rays might be very useful in the case of alloys containing one transparent metal. When Röntgen's great discovery was first published, Professor Austen had examined the relative transparency of certain metals, and endeavoured to detect the difference between hard and soft steel, but the sections of steel employed were too thick, and the experiments were abandoned.

It had been shown by Osmond and by Charpy that eutectic alloys have a pearly structure, and Professor Austen thought that the gold-sodium eutectic shown on the screen by Mr. Heycock also had the pearly structure. As a good example of the distribution produced by freezing, Professor Austen stated that if a triple alloy of copper, antimony, and

lead was cast as a rod and fractured transversely, a purple ring of the "regulus of Venus" (the copper antimony alloy) surrounded the grey alloyed lead which was driven to the centre, so that there was a grey rod inside a purple tube. He hoped that Messrs. Heycock and Neville, who were so greatly extending our knowledge of alloys, would continue their investigations.

The PRESIDENT remarked that this was an important and interesting communication, as illustrating the service the Röntgen rays might be to the chemist. Soon after the announcement of the original discovery, he made experiments on the transparency of the elements to the new rays, and took a number of photographs. In a verbal communication to the Royal Society, he had announced that the opacity of elements to the rays increased in the same series with their atomic weight. He thought the rays might sometimes be of use in settling doubtful cases of atomic weight. For example, if liquid or solid argon were found to be less transparent than oxygen or nitrogen in a similar condition, it might be safely concluded that its atomic weight is higher than that of either of the other constituents of air.

RESEARCH FUND.

A meeting of the Research Fund Committee will be held in June. Applications for grants, accompanied by full particulars, should be sent to the Secretaries before June 8th.

LIST OF FELLOWS.

A new list of Officers and Fellows of the Chemical Society being in course of preparation, it is requested that Fellows will send any alteration of address, without delay, to the Assistant Secretary, Burlington House, London, W.

At the next meeting, on Thursday, May 20th, the following Papers will be received. The authors of those marked with an asterisk have announced their intention of being present.

* "The theory of osmotic pressure and the hypothesis of electrolytic dissociation." By Holland Crompton.

* "Molecular rotations of optically active salts." By Holland Crompton.

* "Heats of neutralisation of acids and bases in dilute aqueous solution." By Holland Crompton.

* "A comparative crystallographical study of the normal selenates of potassium, rubidium, and caesium." By A. E. Tutton.

* "The platinum-silver alloys ; their solubility in nitric acid." By John Spiller.

PROCEEDINGS
OF THE
CHEMICAL SOCIETY.
EDITED BY THE SECRETARIES.

No. 180.

Session 1896-7.

May 20th, 1897. Professor Dewar, F.R.S., President, in the Chair.

Messrs. H. E. Gardner, William Barlow and Paul Thomas White were formally admitted Fellows of this Society.

Certificates were read for the first time in favour of Messrs. Walter Harry Barlow, 152, Osbaldiston Road, Stoke Newington, N. ; Ernest Stuart Cameron, 51, Pembroke Road, Dublin ; Medwin Caspar Clutterbuck, B.Sc., Ph.D., 61, Beaconsfield Villas, Brighton ; Frank William Harbord, Egham ; B. J. Harrington, Ph.D., McGill College, Montreal ; A. G. Kidston Hunter, Princes Street, Dunedin, N.Z. ; John Edwin Mackenzie, B.Sc., Ph.D., 7, Ramsay Garden, Edinburgh ; Lionel Walter Kennedy Scargill, B.A., 14, Brunswick Place, W. Brighton ; James Porter Shenton, 34, Lansdowne Road, W. Didsbury, Manchester.

Of the following papers, those marked * were read :—

*60. "The theory of osmotic pressure and the hypothesis of electrolytic dissociation." By Holland Crompton.

The author applies the results obtained by Guye, Ramsay and Shields, and others in their investigations on the molecular complexity of liquids to the theory of osmotic pressure. It is found that Van't Hoff's view, that the osmotic pressure of the dissolved substance is in dilute solution equal to the pressure which the substance would exercise in the same volume if in the gaseous state, is applicable when both the dissolved substance and the solvent form normal or monomolecular liquids. It may also apply if both liquids are associated. But if the

dissolved substance is associated and the solvent is monomolecular, the osmotic pressure is then smaller than the theoretical, and becomes inversely proportional to the factor of association x_1 of the dissolved substance. If the solvent is associated and the dissolved compound is monomolecular, the osmotic pressure is greater than the theoretical, and is directly proportional to the factor of association x of the solvent. If the solvent has also an abnormal vapour density, the factor of association of the vapour being a , the osmotic pressure is directly proportional to x/a .

By application of the above conclusions, it is shown that the latent heat of fusion r , melting point on the absolute scale T , and density at the melting point, d , of a liquid are connected by the expression $rd/T = \text{const.}$ in the case of monomolecular liquids, or $rdx/Ta = \text{const.}$ in the case of associated liquids. The mean value of the constant is 0.099, or roughly 0.1. This formula is exactly similar to the Trouton formula, which connects the latent heat of vaporisation, gaseous density, and boiling point on the absolute scale of liquids.

The molecular reduction of the freezing point for monomolecular substances in monomolecular solvents is given by Van't Hoff's formula, $E = 0.01976 T^2/r$, or by the derived formula $E = 0.2 Td$. If, however, the dissolved substance or the solvent are associated, this formula no longer applies, but $E = 0.01976 T^2 x / r a x_1$, or $E = 0.2 Td / x_1$. Exceptions to Van't Hoff's formula for the molecular reduction of the freezing point appear, therefore, whenever association of either the dissolved substance or the solvent takes place, and it is shown that those exceptions observed in the case of electrolytes in aqueous solution are in perfect keeping with the view that electrolytes are monomolecular compounds in solution in an associated solvent, *e.g.*, water. The hypothesis of electrolytic dissociation is not only unnecessary in explanation of these exceptions, but is inconsistent with what is now known of the molecular character of liquids.

A connection is supposed to exist between the specific inductive capacity of a liquid and its power of promoting electrolytic dissociation. The author shows that it is only associated liquids that have high specific inductive capacities, and that the specific inductive capacity is approximately proportional to the cube of the factor of association of a liquid. It is therefore not on the degree of electrolytic dissociation of the dissolved substance, but on the degree of association of the solvent, that the conductivity depends, and the view is taken that electrolytes are salts in the monomolecular fluid state in solution in associated solvents.

***61. "Molecular rotations of optically active salts." By Holland Crompton.**

A fact which is usually quoted as strong evidence in favour of the hypothesis of electrolytic dissociation, is that salts which contain a common optically active ion—either positive or negative—exhibit, in sufficiently dilute aqueous solution, the same equivalent rotatory power. If, however, electrolytes are salts in the monomolecular fluid condition (preceding paper), the observed regularities indicate that monomolecular salts which contain a common optically active radicle have the same equivalent rotation. Those peculiarities which have been observed in the case of the equivalent rotations of optically active electrolytes in aqueous solution, are shown by the author to be also exhibited by the amylic salts of certain organic acids, when these are examined in the free state and not in solution in any solvent. As electrolytic dissociation is in this case entirely out of the question, the hypothesis becomes an unnecessary one in other instances, and the behaviour of optically active electrolytes is merely in keeping with that of other optically active monomolecular salts.

***62. "Heats of neutralisation of acids and bases in dilute aqueous solution." By Holland Crompton.**

The constancy of the heat of neutralisation of an acid by a base is usually explained in accordance with the electrolytic dissociation hypothesis by the assumption that the acid, base, and the resulting salt are all in a dissociated state, and that the only change occurring in the system is the formation of water from its ions. In this paper, the author calls attention to the fact that from Thomsen's *Thermochemische Untersuchungen, Band IV.*, it may be inferred that the replacement in any monomolecular organic compound RH of the H atom by one and the same radicle M , is attended with a constant heat change, which is independent of the character of R , and that for monomolecular compounds the heat of the reaction $RH - H + M$ is constant if M is constant and independent of variations in R . From this it also follows that the heat of the reaction $ROH - OH + M$ is constant. In the neutralisation of an acid RH by a base MOH , we have the changes $M - OH$, $R - H$, $M + R$, $H + OH$. If M is kept constant then two terms in the reaction will be constant, $M - OH$ and $H + OH$. The only variation is then in $R - H$ and $M + R$. But as shown above, for monomolecular compounds $RH - H + M$ is attended with a heat change that is independent of R , and hence if acids and bases in dilute aqueous solution are monomolecular compounds, the heat of neutralisation of any acid by one and the same base is a constant quantity. It may be shown in similar

manner that the heat of neutralisation of any base by one and the same acid is constant, and hence the heats of neutralisation of acids by bases are always the same. The hypothesis of electrolytic dissociation is unnecessary in explanation of the observed phenomena, if it be granted that the dissolved electrolytes are monomolecular compounds.

In the above, since OH is simply another negative radicle R, the heat of the reactions $M - OH$ and $H + OH$ might be expected to exactly balance that of the reactions $H - R$ and $M + R$. This is probably the case when the reactions do not occur in dilute aqueous solution. But in solution while the acid, base, and salt are in a condition comparable with that of their vapours, the water which is formed in the reaction must be transformed from that state to the liquid state of the solvent by which it is surrounded. This implies that the heat of neutralisation of an equivalent of an acid by an equivalent of a base in aqueous solution contains as main factor the heat of condensation of a molecule of water. This latter quality has a value of about 10,800 cal., and the mean value of the heat of neutralisation is 13,500 cal. The difference between the two values is to be mainly attributed to the state of partial association of the base.

DISCUSSION.

MR. PICKERING said whether Mr. Crompton had established his views or not, he had succeeded in throwing much new light on the subject under examination, and had given us further evidence that the theory of dissociation was not the only one through which we might look for an explanation of the phenomena of dissolution.

By way of criticism, the speaker suggested that the means of recognising a liquid to be of the associated or non-associated class at the freezing temperatures was somewhat imperfect, and might, in many cases, lead to erroneous conclusions. He doubted, also, whether the numbers obtained showed that the same solvent indicated consistently the same degree of association when pitted against various monomolecular solutes, as should be the case, and whether the same associated solute, when pitted against various monomolecular solvents, gave similarly consistent results. A stronger objection, however, might be raised in the behaviour of diatomic and triatomic electrolytes in water. According to Mr. Crompton's views, these should both give values of 55.2 for the depression of the freezing point when in extreme dilution; the triatomic electrolytes do so, but diatomic electrolytes give values which show little or no tendency to surpass 37, which is only double instead of three times the 'normal' value.

As regards the heat of neutralisation, the speaker considered Mr.

Crompton's application of a general principle which has been established in organic transformations to similar transformations in inorganic solutions to be both legitimate and ingenious. The simplicity of the principle for organic substances, no doubt, depends on the fact that these substances are nearly saturated compounds, and in dilute solutions of inorganic compounds we are probably also dealing with saturated compounds. Some years ago, the speaker brought before the Society an explanation of the constancy of the heat of neutralisation which was based on chemical grounds, without recourse to the theory of dissociation. Residual affinity was the explanation which was offered, and Mr. Crompton's explanation could be improved by taking residual affinity into consideration. Mr. Crompton accounts for the heat evolved on neutralisation by the condensation of the molecule of water formed; this condensation should certainly be recognised (a fact which the speaker had overlooked in his own communication on the subject), but the heat evolved by it falls short of that of neutralisation by some 3000 cal., and it seems probable that this excess may be accounted for by the salt formed becoming, in the presence of water, more fully saturated than either the acid or the alkali. Each of these latter contains a radicle, H and OH, which is identical with one of the radicles in water itself, and such compounds would, therefore, probably not have their residual affinity entirely saturated by the water, whereas this is not so with the salt, and there is nothing in its case to prevent complete saturation.

Mr. W. C. D. WHETHAM said that although it was impossible to criticise such an interesting paper without having considered its details, he would like to ask Mr. Crompton how he would explain the phenomena of electrical conductivity. On the theory that the ions were free from each other, the observed fact that the conductivity of a dilute solution varied as the concentration was at once explained. The alternative supposition, that the ions worked their way through the solution by means of a continual series of interchanges between the opposite parts of molecules at the instants of collision, would lead to a different result, for the frequency with which such collisions would occur, and therefore the ionic velocities, must vary as the square of the concentration, and since the conductivity depended on the product of the number of ions and their average velocity, it would be proportional to the cube of the concentration.

Then, again, the fact that the velocity of an ion in dilute solution was independent of the other ion present, not only as calculated from the conductivity, but also as directly observed, seemed to favour the idea of dissociation, and was of greater weight than other additive relations, since it involved the properties of the ions when in motion.

The successful calculation of potential differences at the contact of

two solutions on the assumption that the faster-travelling ion moved independently of the other, and so diffused more quickly, must also be remembered. Such phenomena as these must be explained before the dissociation theory could be abandoned. No doubt the theory presented many difficulties, and a successful attempt to explain the facts in some other way would be of extreme interest; but at present the evidence in favour of the dissociation theory seemed very strong.

Dr. SHIELDS, after referring to the difficulty of discussing the paper until all the details were before them, stated that he was not satisfied that Mr. Crompton had made out his case that abnormally large osmotic pressures were due to the association of the solvent. According to the well-known equation, the osmotic pressure, π , of a solution containing n molecules of dissolved substance in N molecules of solvent is represented thus:

$$\pi = \frac{n}{N} \cdot \frac{RT1000\rho}{M}$$

where M denotes the molecular weight of the solvent, ρ the specific gravity of the solution, T the absolute temperature, and R is a constant, viz., 0.0819 litre-atmospheres, when we express the osmotic pressure in atmospheres and the volume of the solution containing 1 g -molecule in litres. In the above equation, the product NM is the weight in grams of the solution containing n g -mols. of the dissolved substances.

If we make up a dilute solution to contain, by intention, n g -mols. of dissolved substance in N g -mols. of a solvent supposed, in the first instance, to be normal or monomolecular, then we get a certain definite value for the osmotic pressure. If, however, the solvent is associated, and x is a measure of its molecular complexity, then instead of having weighed out N g -mols. of solvent, we have in reality only N/x , and since the weight of the solution remains the same, the osmotic pressure must be

$$\pi = \frac{n}{N/x} \cdot \frac{RT1000\rho}{xM}$$

or in other words remain uninfluenced by the degree of association of the solvent.

As regards aqueous salt solutions, Dr. Shields thought Mr. Crompton would encounter serious difficulties in attempting to explain why dilute solutions of binary compounds, such as potassium chloride, had a maximum osmotic pressure of twice the theoretical value, whilst compounds like calcium chloride gave three times the pressure one would expect.

Dr. Shields also called attention to the fact that associated liquids such as water become less associated as the temperature is raised, and asked whether when the particular temperature were reached at which

water becomes 'normal,' salt solutions also become 'normal,' *i.e.*, show the theoretical osmotic pressure corresponding to that temperature and otherwise behave like indifferent substances or non-electrolytes.

Mr. CROMPTON, in reply, explained that in assigning to a particular liquid a monomolecular or an associated character the general results of the work of Guye, Ramsay and Shields and others had as far as possible been adhered to. That the molecular reduction of the freezing point of water by electrolytes was in certain cases, even in the most dilute solutions, below the value required for monomolecular compounds, indicated that the salt was originally associated and that the complex molecules only broke down slowly with rising dilution. Similar instances could be observed in the case of solutions of associated compounds in other solvents, *e.g.*, benzene. Alcohol, which in concentrated solution in benzene gave a molecular weight far higher than the normal, would be found to give correct values in very dilute solution. On the other hand, acetic acid gave even in very dilute solution in benzene a molecular weight of about 110 in place of 60, the splitting up of the associated molecules taking place apparently with greater difficulty in the case of this compound than in that of alcohol. The adequacy of the dissociation hypothesis to explain the electrical properties of salt solutions had not been called in question, but it had been shown that the hypothesis gave no true account of certain other properties of salt solutions which it had hitherto professed to explain. The additive character of the molecular conductivities of dilute salt solutions was merely in keeping with the additive character of nearly all the properties of monomolecular compounds in the fluid condition, as, for example, the molecular volumes, the molecular refractions, the molecular viscosities. If a dissociation hypothesis were adopted to explain additive properties in one case, this would have to be extended to all, and such a thing as a monomolecular fluid compound would be non-existent.

***63. "A comparative crystallographical study of the normal selenates of potassium, rubidium, and cæsium." By A. E. Tutton.**

The main conclusions of this investigation, which is analogous to the one formerly presented concerning the corresponding sulphates (*Trans*, 1894, 65, 628), are as follows.

1. The order of solubility of the three salts follows that of the atomic weights of the three respective metals contained.

2. The values of the morphological angles of the crystals of rubidium selenate are without exception intermediate between those of the analogous angles of the potassium and cæsium salts. The angles are therefore a function of the atomic weight of the metal present.

3. The morphological axial ratios of rubidium selenate are likewise intermediate.

4. The usual habits of the crystals of the three salts exhibit a progressive development of the primary forms, following the progressive change in atomic weight.

5. The directions of cleavage are identical.

6. The relative density and molecular volume increase when a lighter is replaced by a heavier alkali metal. The increase in density is greater when potassium is replaced by rubidium than when the latter is replaced by caesium, and the increase in molecular volume is, on the contrary, greater when rubidium is replaced by caesium. The replacement of sulphur in the sulphates by selenium is accompanied by an increase of molecular volume varying from 6.5 to 6.7 inversely as the weight of the initial molecule.

7. The replacement of potassium by rubidium, and of the latter by caesium, is accompanied in each case by an increase in the separation of the centres of contiguous units of the homogeneous crystal structure, along the directions of each of the morphological axes, the influence of the nature of the alkali metal becoming relatively greater as the atomic weight rises. An extension of volume in all directions also accompanies the replacement of sulphur by selenium.

8. An increase of refractive index is observed to accompany an increase in the atomic weight of the alkali metal, and the increase becomes relatively greater as the atomic weight rises. The replacement of sulphur by selenium is also accompanied by an increase of refractive index, and such increase diminishes in amount as the weight of the initial molecule increases.

9. If the closed optical ellipsoidal figures, the optical indicatrices, of the three salts were constructed about the same origin, the indicatrix of the caesium salt would contain within it that of the rubidium salt, and this again would contain that of the potassium salt. The indicatrix of the rubidium salt would lie nearer to that corresponding to the potassium salt.

10. The replacement of one alkali metal by another of higher atomic weight is accompanied by a diminution of the already feeble double refraction. In the convergence of the axial values of the optical indicatrix towards unity the c value proceeds much more rapidly than the others.

11. The latter fact causes a reversion of the sign of double refraction from positive to negative on attaining the caesium salt.

12. The optic axial angles are precisely such as would naturally follow from the progressive development of the optical indicatrix; a change of direction of the acute bisectrix and of the optic axial plane occurs

when the caesium salt is reached, as the direct result of the continuity of the progression according to atomic weight.

13. The optical properties of the selenates exhibit marked specific differences from those of the sulphates, owing to the progressively different effect of replacing sulphur by selenium in the three sulphates, but the whole of the relationships of these optical properties exhibited by the three salts of each group are of a precisely parallel nature, being functions in each case of the atomic weight of the alkali metal which they contain.

14. Progressive changes occur in the optical properties on raising the temperature, following, even to the least detail, the order of the atomic weights. An interesting direct consequence is that a 60° prism of caesium selenate whose vibration-directions are parallel to b and c affords at 90°C . only one image of the spectrometer slit, the two images usually observed coinciding at this temperature, the crystal being then apparently uniaxial.

15. A further consequence of the foregoing is that the crystals of caesium selenate exhibit unique interference phenomena in convergent polarised light when their temperature is raised, including crossed axial plane dispersion, and two reversals of the sign of double refraction. Section-plates perpendicular to all three axes in turn require to be employed in order to follow the optic axial changes even as far as 280°C .

16. The whole of the molecular optical constants of rubidium selenate are intermediate between those of potassium and caesium selenates. The replacement of sulphur by selenium is accompanied by an increase of molecular refraction of $3.4\text{--}3.8$ Lorenz or $6.2\text{--}6.7$ Gladstone units, according to the direction chosen for comparison. The relations of the three salts of each group as regards molecular refraction are identical, but the actual differences are slightly greater in the selenate group than in the sulphate group.

17. The molecular refraction of each of the three selenates for the state of solution in water is approximately the same as the mean of the three values for the crystal. When potassium selenate is dissolved in water, its refraction equivalent rises by 2.8 per cent; in the case of rubidium sulphate, a less rise of 1.0 per cent. is observed, while for caesium selenate there is no longer a rise but a decrease, to the extent of 0.5 per cent. These slight differences, due to change of state, thus exhibit a progression varying directly as the specific refractive energy and inversely as the atomic weight of the alkali metal contained in the salt. After subjecting Kanonnikoff's value for dissolved potassium sulphate to revision, precisely similar differences for the two states are shown to exist in the sulphate group.

18. The author finally concludes as regards the selenates that—

The whole of the morphological and physical properties of the crystals

of the rhombic normal selenates of potassium, rubidium, and caesium are functions of the atomic weight of the alkali metal present.

19. It is shown that the joint results of the investigations of the sulphates and selenates agree with the assumption that—

The characters of the crystals of isomorphous series are functions of the atomic weight of the interchangeable elements, belonging to the same family group, which give rise to the series.

DISCUSSION.

Dr. GLADSTONE remarked that everyone recognised in a general way that in groups of analogous elements there is a gradual progression in the properties, the middle member of the group being intermediate, not only in atomic weight, but also in other respects. The value of Mr. Tutton's elaborate papers, is, that he has proved this up to the hilt quantitatively in the case of two similar, well defined groups of salts, and that with regard to a large number of properties. The change in the specific refraction of the selenates of the alkalis in their crystalline and their dissolved condition is especially instructive, as it involves the change from *plus* in potassium and rubidium to *minus* in caesium. The correction of Kanonnikoff's number for the potassium sulphate which Mr. Tutton has made brings the atomic refraction back to a figure practically identical with that published in Dr. Gladstone's paper of 1870, viz., 33·11.

*64. "The platinum-silver alloys; their solubility in nitric acid."

By John Spiller.

Referring to the published statements in the text-books, and particularly to those in Percy's *Metallurgy* and Bloxam's *Chemistry*, according to which 5 or even 9 per cent. of platinum followed the silver into solution when their alloys were treated with nitric acid, the author investigated the properties of ten graduated alloys constituted as follows:—Series I, containing 12, 9 and 5 per cent. of platinum; series II, containing 2, 1·5, 1 and 0·75 per cent. of platinum; series III, containing 0·5, 0·4 and 0·25 per cent. of platinum. These alloys were prepared by fusion of the requisite proportions of silver and platinum under a gas-air blow-pipe flame in shallow porcelain cups, and then attacked by nitric acid of three different strengths, when it was found that the ordinary concentrated acid of 1·42 sp. gr., warmed, proved the best solvent, but that even under the most favourable conditions no more than 0·75 to 1·25, mean 1 per cent. of platinum, could be dissolved along with the silver.

When diluted nitric acid of 1·2 sp. gr. was employed, the maximum

amount of platinum taken up was only about 0.25 per cent.; whilst the highly concentrated acid of 1.50 sp. gr. proved altogether inappropriate, giving a bulky, insoluble product consisting of platinum black, intermixed with nearly the whole of the silver nitrate formed.

It would appear, then, that Berthier's account, quoted by Percy, and the statement in Bloxam's *Chemistry* are incorrect.

DISCUSSION.

Mr. VERNON HARCOURT suggested that the composition of the alloys of platinum and silver might vary with the temperature at which they were formed, and that Mr. Spiller should determine the solubility of alloys formed at higher temperatures than those he had employed.

Mr. FRISWELL thought that impurities in the nitric acid might account for some of the discrepant statements on record.

65. "Dalton's law in solutions. The molecular depression of mixtures of nonelectrolytes." By Meyer Wilderman, Ph.D.

Since Van't Hoff has shown that the generalisations arrived at by Boyle and Guy-Lussac in the cases of gases are equally applicable to dissolved substances in dilute solutions, the conclusion must be drawn that the third gaseous law, the law of Dalton, holds for dilute solutions also, this being a necessary consequence of the nature of osmotic pressure. Following up the thermodynamic considerations of Planck, the equations for mixtures of two or more electrolytes and the experimental proof of them are given.

66. "The action of bromdiphenylmethane on ethyl sodacetoacetate." By G. G. Henderson D.Sc., M.A., and M. A. Parker, B.Sc.

While bromtriphenylmethane and ethylsodacetoacetate interact to give a disubstituted derivative, $(CPh_3)_2 \cdot CAc \cdot CO_2Et$, and ethyl acetoacetate, bromdiphenylmethane, on the other hand, appears to yield only a monosubstituted ester, *ethyl α -acetyl- β -diphenylpropionate*, $CHPh_2 \cdot CHAc \cdot CO_2Et$.

This substance was prepared by heating bromdiphenylmethane (1 mol.) and ethyl sodacetoacetate (1 mol.) in presence of pure dry benzene or xylene till the reaction was completed, filtering from sodium bromide, concentrating the benzene solution, and purifying the crystals, which then separated, by recrystallisation from alcohol. It crystallises in shining, colourless needles, m. p. 85° , is sparingly soluble in alcohol but readily in benzene, and decomposes almost entirely when distilled.

On hydrolysis of this ester with cold dilute aqueous potash, a small quantity of *α -acetyl- β -diphenylpropionic acid*, $CHPh_2 \cdot CHAc \cdot COOH$, was obtained in the form of extremely unstable crystals, which melt

about 90° and decompose at a slightly higher temperature. The salts of this acid are also very unstable. β -diphenylethylmethylketone, $\text{CHPh}_2 \cdot \text{CH}_2 \cdot \text{CO} \cdot \text{CH}_3$, was prepared by hydrolysing the ester with hot dilute alcoholic potash. It crystallises in colourless prisms which melt at 87.5° and distils with almost no decomposition at 315° . It is fairly readily soluble in alcohol, and very readily in benzene. The *oxime*, $\text{CHPh}_2 \cdot \text{CH}_2 \cdot \text{C}(\text{CH}_3) : \text{N} \cdot \text{OH}$, forms small, colourless crystals, m. p. $86-87^{\circ}$. It is sparingly soluble in alcohol but readily soluble in benzene. The *semicarbazone*, $\text{CHPh}_2 \cdot \text{CH}_2 \cdot \text{C}(\text{CH}_3) : \text{N} \cdot \text{NH} \cdot \text{CO} \cdot \text{NH}_2$, crystallises from alcohol in small, white clusters of minute crystals, which melt at 181° . It is sparingly soluble in alcohol and in benzene.

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McAdie, A. Equipment and Work of an Aero-physical Observatory. Washington 1897. 8vo. Pp. 30. From Smithsonian Miscellaneous Collections, 39. (Number 1077.)

Russell, F. A. R. The Atmosphere in Relation to Human Life and Health. Washington 1896. 8vo. Pp. 148. From Smithsonian Miscellaneous Collections, 39. (Number 1072.)

Varigny, Henry de. Air and Life. Washington 1896. 8vo. Pp. 69. From Smithsonian Miscellaneous Collections, 39. (Number 1071.)

From the Smithsonian Institution.

Griffiths, A. B. Respiratory Proteids Researches in Biological Chemistry. Pp. viii + 126. London 1897. From the Author.

RESEARCH FUND.

A meeting of the Research Fund Committee will be held in June. Applications for grants, accompanied by full particulars, should be sent to the Secretaries before June 8th.

LIST OF FELLOWS.

A new list of Officers and Fellows of the Chemical Society being in course of preparation, it is requested that Fellows will send any alteration of address, without delay, to the Assistant Secretary, Burlington House, London, W.

At the next meeting, on Thursday, June 3rd, the following Papers will be received. The authors of those marked with an asterisk have announced their intention of being present.

* "On the thermal phenomena attending the change of rotatory power of freshly-prepared solutions of certain carbohydrates; with some remarks on the cause of multirotation." By Horace T. Brown, F.R.S., and Spencer Pickering, F.R.S.

* "On the thermo-chemistry of carbohydrate-hydrolysis: (I.) The hydrolysis of starch by vegetable and animal diastase. (II.) The hydrolysis of cane-sugar by invertase." By Horace T. Brown, F.R.S., and Spencer Pickering, F.R.S.

* "Optical inverson of camphor." By Frederic Stanley Kipping, Ph.D., D.Sc., and William Jackson Pope.

* "Derivatives of camphoric acid. Part II. Optically inactive derivatives." By F. Stanley Kipping, Ph.D., D.Sc., and William Jackson Pope.

* "Racemism and Pseudoracemism. F. Stanley Kipping, Ph.D., D.Sc., and William Jackson Pope.

* "Note on some new gold salts of the Solanaceous alkaloids." By H. A. D. Jowett, D.Sc.

CERTIFICATES OF CANDIDATES FOR ELECTION.

N.B.—The names of those who sign from “General Knowledge” are printed in *italics*.

The following have been proposed for election. A ballot will be held on Thursday, June 17th.

Ackroyd, William,

9, Grandsmere Place, Halifax, Yorks.

Analyst. Public Analyst and Gas Examiner for Halifax. Fellow of the Institute of Chemistry, &c. Author of “The Old Light and the New ; dealing with the Chemistry of Colour and the New Photography.” During the last 20 years has published papers on Chemistry and Physics in the *Phil. Mag.*, *Chem. News*, *Proceedings* of the Phys. Soc. Lond., and the Royal Soc. Edin.

R. Meldola.

Arthur Smithells.

Alfred H. Allen.

A. G. Green.

C. Rawson.

G. W. Slatter.

Walter Leach.

Barlow, Walter Harry,

152, Osbaldeston Road, Stoke Newington, N.

Analytical Chemist. Associate of the Institute of Chemistry. Certificated Student of Finsbury Technical College, 1890—95. Fourteen months Assistant Chemist at Gas Light and Coke Co.'s Works, Beckton. At present Assistant to Dr. Attfield, F.R.S.

R. Meldola.

John Attfield.

R. C. T. Evans.

J. Theo. Hewitt.

Arthur J. Chapman.

Brothers, William Malam,

Beechwood House, Prestwich, near Manchester.

Chemist. Studied Chemistry and Physics for the past six years at Bury Grammar School under Mr. W. French, M.A., F.I.C. For the past two years have been Chemist to Higher Clews Chemical Works, Rawtenstall. At present studying under Mr. French for the Honours Chemistry of South Kensington and Institute of Chemistry, and

desirous of obtaining the *Journal* for the current literature of the subject.

William French.

Edward Haworth.

Wm. Hesketh.

Christopher Wilson.

W. H. Barr.

Brown, Gerald Noël,

8, The Esplanade, Plymouth.

Analytical Chemist and Metallurgist. Associate of the Royal College of Science (Chemistry), 1894. Associate of the Royal School of Mines (Metallurgy), 1895.

Chapman Jones.

T. E. Thorpe.

W. Palmer Wynne.

Henry C. Jenkins.

Boverton Redwood.

W. C. RobertsAusten.

William A. Tilden.

Cameron, Ernest Stuart,

51, Pembroke Road, Dublin.

Demonstrator of Chemistry in the Royal College of Surgeons of Ireland, and Public Analyst for the County of Dublin.

Bernard Dyer.

James Dewar.

Alfred Smetham.

Otto Hehner.

Alfred Gordon Salamon.

Boverton Redwood.

Sydney Steel.

J. F. H. Gilbard.

Clutterbuck, Medwin Caspar,

61, Beaconsfield Villas, Brighton.

Lecturer on Chemistry to the Municipal School of Science and Art, Brighton. B.Sc. Lond., Ph.D. Strassburg, late Chemical Scholar of Un. Coll., Bristol. Joint Author with Prof. Fittig of an original research on tetrolic acid. Two years manager of Dallan Chemical Works, Burton-on-Trent. For the last three years Lecturer on Chemistry to the Municipal School of Science and Art, Brighton.

William Ramsay.

G. Harris Morris.

Sydney Young.

S. F. Dufton.

John Shields.

Cranfield, William,

5, Second Avenue, Halifax.

Teacher of Chemistry. Now and for several years past chief teacher of Chemistry at the Higher Grade Board School, Halifax. Studied at the Westminster Training College under S. Parrish, Esq., F.C.S., and at the Yorkshire College, Leeds.

Arthur Smithells.

John M. Thomson.

S. Parrish.

J. B. Cohen.

Herbert Ingle.

Gomess, A. F. Bilderbeck,

24A, Alfred Place West, South Kensington.

Medical. Late Assistant Pathologist, St. George's Hospital (including Pathological Chemistry). Passed final examination R.C.P., *i.e.*, the Medical portion of the Conjoint Scheme L.R.C.P., M.R.C.S. Gave demonstration at the International Congress (with Professor Delipine) for the prevention of air pollution with some of the products of combustion of coal.

Samuel Rideal.

William Henry Walenn.

H. E. Roscoe.

Frank Scudder.

Henry E. Armstrong.

Grundey, Frederick Roscoe,

20, Derby Road, Douglas, Isle of Man.

Science Teacher (Chemistry and Physics). Bachelor of Science (Vict.), Chemistry and Physics. Student in Owens College, Manchester, for 3 years. Teacher of Chemistry and Physics in the Organised Science School, Douglas, Isle of Man.

H. B. Dixon.

E. Haworth.

A. Harden.

W. H. Perkin, jun.

G. H. Bailey.

Halliwell, Edward,

Alexandra Crescent, Dewsbury.

Analytical Chemist and Associate of the Institute of Chemistry. Gained a Scholarship at the Yorkshire College, Leeds, for 3 years, 1891—4, and took full courses in Chemistry, Physics and certain Art Subjects. In 1894 passed the "Institute of Chemistry" examination for A.I.C., and have since been engaged in general analytical and chemical work in the laboratory of Mr. T. Fairley, Leeds.

Arthur Smithells.

J. J. Hummel.

Wyndham R. Dunstan.

Thomas Fairley.

Herbert Ingle.

Julius B. Cohen.

Sydney Young.

B. A. Burrell.

Harbord, Frank William,

Egham, Surrey.

Analytical Chemist. Assoc. R.S. Mines, Fellow of Institute of Chemistry. For 7 years Chemist to the Staffordshire Steel Co. Two years Chemist and Steel Works Manager to Messrs. Hatton, Sons & Co., Bilston, Staffs. For last 5 years Analytical Chemist to Indian Government, R.I. Engineering College, Cooper's Hill, Staines.

Herbert McLeod.

Bennett H. Brough.

F. E. Matthews.

W. R. Hodgkinson.

A. H. Church.

Harman, Harold,

Brewers Sugar Co., Greenock.

Chemist to Brewers Sugar Co., Greenock. Studied Chemistry at the Royal College of Science, South Kensington. Research Chemist in Mr. Lawrence Briant's Laboratory. Now Chemist to the Brewers Sugar Co., Greenock.

Lawrence Briant.

Arthur J. Starey.

Thos. Stevenson.

Cuthbert Vaux.

Chapman Jones.

William Crookes.

William Briggs.

Harrington, B. J.,

Montreal.

Professor of Chemistry McGill College, F.R.S.C., F.G.S., Ph.D., &c. Author of a number of original papers in the *Transactions* of the Royal Society of Canada, the *American Journal of Science* and others, more especially on the chemistry of rare and new minerals.

William A. Tilden.

W. C. Roberts-Austen.

*William Ramsay.

William Crookes.

J. H. Gladstone.

Hunter, A. G. Kidston,

Colonial Mutual Buildings, Prince's St., Dunedin, N. Zealand.

Professor of Chemistry. Studied under the late Prof. Dittmar, Glasgow and West of Scotland Technical College. Author of "Examination of a Potable Water from a Bacteriological and Chemical point of view" (Paper read at Intercolonial Medical Congress, Dunedin, 1896). At present Professor of Chemistry in, and Principal of, Otago College of Pharmacy, Dunedin, New Zealand. Public analyst, &c.

James M. Mason.

John McArthur.

G. G. Henderson.

A. Humboldt Sexton.

James Robson.

Matthew A. Parker.

Johnston, George Lawson,

Kingswood, Sydenham Hill.

Director Bovril Limited. Attended Course Organic Chemistry Lectures, Royal College of Science, Kensington. Three years' analytical work under H. R. Gregory, F.I.C., and in private laboratory (analysis of foods particularly). Member of Chemical Industrial Society.

Playfair.

A. Searl.

Wm. Harkness.

S. Arch. Vasey.

James Dewar.

R. Bannister.

J. Woodward.

C. Proctor.

Mackenzie, John Edwin,

7, Ramsay Garden, Edinburgh.

Ph.D. (Strassburg), B.Sc. (Edin.) Assistant Professor of Chemistry, Heriot-Watt College, Edin. "Dimethoxydiphenylmethane and some of its Homologues," *Chem. Soc. J.*, 1896, 987. $\alpha\beta$ - und $\beta\gamma$ -Pentensäure," Liebig's *Annalen der Chem.*, 283, 82. With A. G. Perkin, "Action of Nitric Acid upon Anthracene," *Chem. Soc. J.*, 1892, 865. With W. H. Perkin, jun., Ph.D., "Synthesis of Hexahydroterephthalic Acid," *Chem. Soc. J.*, 1892, 172. With F. S. Kipping, Ph.D., D.Sc., "Ethyl- $\alpha\alpha'$ -Dimethyl- $\alpha\alpha'$ -diacetylpinelate and some of its Decomposition Products," *Chem. Soc. J.*, 1891, 569.

Alex. Crum Brown.

J. Gibson.

W. H. Perkin, jr.

A. G. Perkin.

F. Stanley Kipping.

Pollock, William Robertson,

Kirkland, Bonhill, Dumbartonshire.

Assistant Manager in Turkey Red Dye-Work. Three years a chemical student in the Glasgow Technical College under Profs. Dittmar, Henderson, and Mills; engaged in a calico print works for $1\frac{1}{2}$ years; for two years and at present on the staff of Messrs. Archibald Orr Ewing & Co., Dillichip; Bronze and Silver Medallist of the City and Guilds of London Institute.

Edmund J. Mills.

G. G. Henderson.

A. Humboldt Sexton.

R. R. Tatlock.

T. I. Patterson.

Scargill, Lionel Walter Kenredy,

14, Brunswick Place, West Brighton.

Schoolmaster. Honours in the Final School of Natural Science, Oxford. For the past year Science Teacher in the Langport Grammar School.

John Conroy.

D. H. Nagel.

P. Elford.

W. W. Fisher.

V. H. Veley.

Shenton, James Porter,

34, Lansdowne Road, West Didsbury, Manchester.

Analytical Chemist. A pupil of Messrs. Crace Calvert and Thomson, Royal Institution Chemical Laboratory, Manchester, from 1887 to 1890. Junior Assistant in the same laboratory from 1890 to June,

1894. Senior Assistant in the same laboratory from June, 1894, up to the present time.

William Thomson.

C. Estcourt.

Alfred H. Allen.

Otto Hehner.

J. Carter Bell.

P. Anderson Estcourt.

Charles E. Cassal.

Thomas Fairley.

Taverner, William,

1, Stapenhill Road, Burton-on-Trent.

Brewers' Chemist, in the employ of Messrs. Worthington & Co., Burton-on-Trent. I have for three years held the position of Chief Chemist to the above-mentioned firm, having previously worked for five years as Assistant Analyst in the Inland Revenue Laboratory, Somerset House. I received my chemical training first at the University College, Dundee, and afterwards at the Royal School of Mines, South Kensington, and the Somerset House Laboratory.

R. Bannister.

E. Grant Hooper.

J. Woodward.

H. J. Helm.

C. Proctor.

J. H. Robbins.

PROCEEDINGS

OF THE

CHEMICAL SOCIETY.

EDITED BY THE SECRETARIES.

No. 181.

Session 1896-7.

June 3rd, 1897. Professor Dewar, F.R.S., President, in the Chair.

Messrs. Thomas Tickle and Thomas Girtin were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. John Ball, Ph.D., 18, Redshaw Street, Derby; Alec Alfred Beadle, Beadonwell, Belvedere, Kent; James Walter Horseman, 5, South Parade, Chelsea, S.W.; Charles John Jodrell Mansford, B.A., Lady Manners Grammar School, Bakewell, Notts.; Thomas Southern, jun., 2, Cherry Mount, The Cliff, Higher Broughton, Manchester; Francis Samuel Young, M.A., Mill Hill School, N.W.

Of the following papers, those marked * were read:—

- *67.** "On the thermal phenomena attending the change of rotatory power of freshly-prepared solutions of certain carbohydrates; with some remarks on the cause of multirotation." By Horace T. Brown, F.R.S., and Spencer Pickering, F.R.S.

During an investigation of the thermal changes attending hydrolysis under enzyme action, whose results are described in the next paper, it became necessary to enquire whether the change in the multi-rotation of certain sugars is attended with any heat disturbance, as it is now well known that, at any rate, dextrose and maltose are liberated by hydrolysis in the "birotatory" state. The authors find that the changes of rotation experienced by dextrose, lævulose, and milk-sugar in passing from the optically unstable α - to the optically stable β -form, are accompanied by distinct thermal effects which, although taking

place slowly in the solutions under ordinary conditions, can be produced, like optical stability, almost instantaneously by the addition of traces of an alkali. A full account is given of the apparatus employed, of the method of experiment, and the nature of the corrections to be applied. In the cases of dextrose and milk-sugar, there is a liberation of heat accompanying the change of rotatory power; with lævulose there is a very decided absorption; and with maltose no thermal disturbance is recognisable. The following are the values obtained.

	Per gram of sugar.	Per gram- molecule.
Dextrose	+ 0.588 cal.	+ 106 cal.
Lævulose	- 4.64 cal.	- 835 cal.
Milk-sugar	+ 0.19 cal.	+ 34 cal.
Maltose	0	0

The authors discuss the various explanations which have been given from time to time to account for multirotation, and consider that their experiments favour the view that it is conditioned by chemical rather than physical causes, and that Fischer is probably correct in his suggestion that dextrose, for instance, in passing from the optically unstable to the optically stable modification in solution, passes from the aldehyde, $C_6H_{12}O_6$, to the heptahydric alcohol, $C_6H_{14}O_7$. They believe, however, that the analogy which Fischer suggested, of the change of a lactone into its acid, is less close than that afforded by the gradual change of acetic aldehyde, in contact with water, into ethylidene glycol where the CHO group becomes $CH(HO)_2$.

***68.** "On the thermo-chemistry of carbohydrate-hydrolysis: (I) The hydrolysis of starch by vegetable and animal diastase. (II) The hydrolysis of cane-sugar by invertase." By Horace T. Brown, F.R.S., and Spencer Pickering, F.R.S.

The attempts made to determine the thermal effects of hydrolysis have hitherto been confined to indirect methods, based on the heats of combustion of the hydrolysable substance and its products. Such methods, it is shown, cannot give results of any real value, as the thermal changes to be measured are considerably within the experimental errors of the combustion values.

The paper describes the results obtained by direct measurement of the heats of hydrolysis of starch and of cane-sugar. Lintner's soluble-starch was for the most part used, as there are certain mechanical difficulties in employing starch-paste in the calorimeter, owing to its viscosity. The hydrolytic agents used for starch were (1) malt-diastase, (2) pancreatic-diastase, (3) Taka-diastase, and (4) saliva. With malt

diastase, the heat of hydrolysis was found to be +2.60 calories per gram of amylin converted into maltose. The amount of heat is proportional to the water fixed, and is independent of the molecular complexity of the amylin attacked. The breaking down of the starch-molecule prior to hydrolysis does not appear to be attended with any thermal disturbance.

With pancreatic-diastase, the heat liberated per gram of amylin hydrolysed amounts to +1.8 cal., a value sensibly less than that deduced from the action of the malt-diastase. With Taka-diastase, the heat disturbance is still less than with the other two agents. The possible causes of these differences are discussed.

Cane-sugar was hydrolysed with invertase, and was found to give a thermal effect of +11.21 cal. per gram of cane-sugar inverted when the products were in the optically stable β -form, and 13.34 cal. per gram at the moment of liberation of the products, *i.e.*, when they are in their "birotatory" or optically unstable form. It is the larger number which correctly represents the heat of hydrolysis of cane-sugar.

DISCUSSION.

MR. PICKERING made a statement as to some additional work which had been done in connection with the subject since the paper had been sent in to the Society. The nature of the change produced by water on the sugars has been suggested to be the conversion of the aldehyde groups present into aldehydol groups, an action which there is every reason to believe occurs in the case of acetic aldehyde itself, and experiments were, therefore, made to ascertain whether the action in the case of aldehyde exhibits the same peculiarity as in the case of the sugars, of being greatly accelerated by the addition of alkali. This was found to be the case, and the analogy of the two actions is, therefore, greatly strengthened. In both cases, also, the ammonia combines directly with the substance—the sugar or the aldehyde—with evolution of heat, but the results with aldehyde show that the formation of these compounds is not the cause of the hydrating effect of the alkali, for, although the alkali renders the hydration instantaneous, the formation of the aldehyde ammonia proceeds gradually, and with the quantities used is complete only after seven or eight minutes, the action evidently being independent of, and posterior to, the hydration. The accelerative action of the alkali on the hydration is probably due to its increasing the number of free molecules of water present in the liquid, by forming continually dissociating compounds such as NH_4OH , $\text{NaOH} \cdot \text{H}_2\text{O}$, &c., and a free molecule of water would be a far more active hydrating agent than the average water aggregate constituting the bulk of liquid.

Mr. A. R. LING said he was under the impression that Béchamp, and subsequently Tollens, were the first to point out that the multirotation of carbohydrates was correlated with thermic phenomena, but neither had made the exact measurements now presented. He wished to know if the authors had observed any change in the density of the solutions before and after the transition from the abnormal to the normal rotatory power.

Dr. KIPPING said that although it seems to be generally understood that the phenomenon of birotation is not the result of a purely physical change, the assumption that it is due to the mere hydration of the aldehyde group might be objected to as involving the apparent contradiction that a very considerable change in specific rotation is brought about, not by increasing or diminishing the number of asymmetric carbon atoms in the molecule, but by merely altering to a comparatively slight extent the asymmetry of the groups already present. Important data in support of the chemical or hydration explanation of birotation were afforded, however, by some experiments made at the suggestion of Emil Fischer, as it had been found (Jacobi, *Ann.*, 1892, 272, 170) that the rapidity of the formation of a hydrazone from a sugar which showed birotation varied with the time which had elapsed since the sugar had been dissolved.

Mr. HORACE BROWN, in reply, said that he believed Mr. Ling was mistaken in his statement that Béchamp or Tollens had done anything to correlate multirotation with thermic phenomena. So far as he knew, the only previous work on this subject was that of Berthelot, who had indirectly determined, for the solid state, the heats of transformation of α - and γ -dextrose into the β form.

Up to the present time, the authors had been unable to discover any change of density in solutions of multirotatory sugars.

Whilst fully admitting the force of Dr. Kipping's objections, it must be remembered that, so far as our knowledge goes at present, we are not justified in denying that comparatively small changes in the asymmetry of groups may be attended with a considerable change in rotatory power. The experiments of Jacobi are fully described in the paper, and are regarded by the authors as strongly confirmatory of their views.

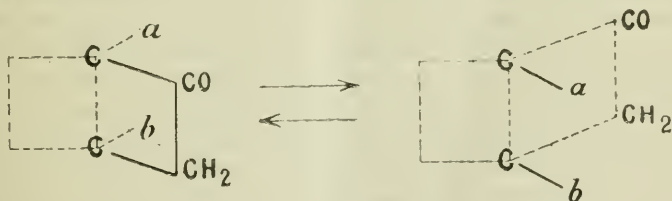
***69. "Optical inversion of camphor." By Frederic Stanley Kipping Ph.D., D.Sc., and William Jackson Pope.**

It was shown some time ago (Trans., 1893, 63, 548) that two optically active isomeric sulphonic chlorides of the composition $C_{10}H_{15}O \cdot SO_2Cl$ could be obtained from the product of the action of anhydrosulphuric acid on ordinary *d*-camphor; these two compounds differed only in

optical and crystallographic properties, and it was therefore concluded that they must be regarded as optical antipodes.

This conclusion has been fully borne out by some recent work, in the course of which the properties of a considerable number of inactive compounds, prepared from inactive camphorsulphonic chloride, have been examined; it has thus been proved beyond doubt that these inactive compounds are composed of equal quantities of two enantiomorphous camphor derivatives, and that, consequently, either before or during sulphonation, the original *d*-camphor must be partly converted into its optical antipodes, *l*-camphor.

In the present paper, particular attention is drawn to this interesting case of optical inversion, as the intramolecular changes which take place appear to be entirely different from those which occur in the case of substances which contain asymmetric carbon atoms as constituents of an open chain. Although the constitution of camphor is still a matter for further investigation, it is now almost universally admitted that the skeleton of this substance consists of two closed carbon chains having two or more carbon atoms in common; further, a study of the chemical and optical properties of the various modifications of camphoric acid leads to the conclusion that each of the carboxyl groups in camphoric acid is united to an asymmetric carbon atom (Aschan, *Acta Soc. Scient.*, 21, [5], 1—227). Admitting these two apparently well-founded assumptions, the conversion of *d*- into *l*-camphor requires that part of one of the closed chains, for example, the group $\text{—CH}_2\text{—CO—}$, should change places with the two atoms *a* and *b* as shown in the following scheme.



As this view is based upon the two assumptions already stated, the matter is discussed from other standpoints, and it is finally concluded that the changes which occur in the optical inversion of camphor are of the nature already suggested.

*70. "Derivatives of camphoric acid. Part II. Optically inactive derivatives." By F. Stanley Kipping, Ph.D., D.Sc., and William Jackson Pope.

The optically inactive, externally compensated derivatives of camphoric acid described in this paper were prepared initially from ordinary

d-camphor by first converting this substance into the approximately inactive camphorsulphonic chloride (Trans., 1893, 63, 547) or camphorsulphonic bromide (Trans., 1895, 67, 354), from which inactive π -chlorocamphor and racemic π -bromocamphor were then obtained by the method previously employed (Trans., 1895, 67, 371).

Inactive π -chlorocamphoric acid, $C_{10}H_{15}ClO_4$, prepared by oxidising inactive π -chlorocamphor with nitric acid, crystallises in flat plates or in prisms, and melts at about 194 — 195° ; its *anhydride*, $C_{10}H_{13}ClO_3$, melts at 193 — 194° .

Inactive π -bromocamphoric acid, $C_{10}H_{15}BrO_4$, obtained in a similar manner from racemic π -bromocamphor, is a crystalline powder melting at about 203 — 204° ; its *anhydride*, $C_{10}H_{13}BrO_3$, melts at 155 — 156° .

These four externally compensated substances resemble the corresponding active compounds (Kipping, Trans., 1896, 69, 913; Lapworth and Kipping, Trans., 1897, 71, 1) very closely in general properties, but the inactive anhydrides are not easily obtainable in large crystals, active π -bromocamphoric anhydride forms large, monosymmetric crystals, measurements of which are given.

Inactive trans- π -camphanic acid, $C_{10}H_{14}O_4$, is obtained by the decomposition of the sodium salt of π -chloro- or π -bromocamphoric acid. It crystallises from water in monosymmetric prisms, which contain one molecule of water of crystallisation, but from ethylic acetate it is deposited in anhydrous, monosymmetric, six-sided plates; the anhydrous crystals change in crystalline form at about 130° and melt at 164 — 165° , namely, at the same temperature as the anhydrous active acid.

Active trans- π -camphanic acid (Trans., 1896, 69, 929) has been further investigated, and has been found to exist in a number of different crystallographic modifications; it separates from cold water in hydrated prisms, very similar to those of the inactive acid in all respects, and it is also deposited in hydrated monosymmetric prisms from its solution in ethylic acetate; when crystallised from benzene, it affords either well-defined orthorhombic needles which contain one molecule of water of crystallisation, or a microcrystalline powder of the anhydrous acid, according to the conditions of the experiment. From a mixture of chloroform and light petroleum, it is deposited in large, transparent, anhydrous orthorhombic prisms which change in crystalline form at 100° .

The conclusions to be drawn from these and other facts bearing on the relation between the active and inactive trans- π -camphanic acids are discussed in the following paper.

Inactive cis- π -camphanic acid, $C_{10}H_{14}O_4$, is the principal product of the distillation of trans- π -camphanic acid. It crystallises in large, transparent, hexagonal plates, which are indistinguishable from those of the corresponding active acid (Trans., 1896, 69, 943) except in optical

behaviour ; the crystals of the active acid are circularly polarising and all of one kind, whereas those of the inactive substance show either right- or left-handed circular polarisation. It is thus possible to separate this externally compensated *cis*- π -camphanic acid into its *d*- and *l*-isomeric components.

Inactive trans-camphotricarboxylic acid, $C_{10}H_{14}O_6$, is obtained when inactive *trans*- π -camphanic acid is oxidised with nitric acid ; it crystallises from water in lustrous transparent, monosymmetric prisms, which differ from those of the active acid (*Trans.*, 1896, 69, 951) deposited under similar conditions in being anhydrous, and consequently also in crystalline form. It melts at 224—225°, whereas the active acid melts at 196—197°.

Inactive trans-camphotricarboxylic anhydride forms transparent, monosymmetric crystals which are remarkably similar to those of the active anhydride ; it melts at 253—254° whether heated alone or with an approximately equal quantity of the active substance.

***71. "Racemism and pseudoracemism." By F. Stanley Kipping, Ph.D., D.Sc., and William Jackson Pope.**

The data afforded by a comparison of the physical and crystallographic properties of the optically inactive substances described in the preceding paper with those of the corresponding active compounds (*Trans.*, 1896, 69, 913), and a number of other facts collected during the investigation of various active and inactive π -derivatives of camphor, have led the authors to the conclusion that the present classification of externally compensated substances into (*a*) mere mixtures and (*b*) racemic compounds, requires modification.

It has been found that optically inactive substances which are not mere mixtures of individual crystals of each of the enantiomorphous components are either very similar to, or extremely different from, their isomeric constituents in all those properties more immediately connected with crystalline structure ; no intermediate degree of similarity is, in fact, observable in any case where these properties have been thoroughly examined.

Such externally compensated substances fall, therefore, into two groups. Those which closely resemble the corresponding active compounds are called *pseudoracemic*, the name racemic compound being reserved for those of the other group, of which racemic acid is the classical example.

The subdivision of optically inactive compounds has, not only an experimental, but also a theoretical basis. It can be shown that, in accordance with the present theory of crystalline structure, optically active and racemic compounds cannot assume the same type of homo-

geneous crystalline structure, but that an externally compensated substance may form crystalline individuals extremely similar to, but still not identical with, those of its active isomerides; in the latter case, the crystals consist of mere intercalations of those of the active modifications, and the non-identity is the result of the disturbance set up by intercalation. It is to these substances that the term pseudoracemic is applied.

Definitions of pseudoracemic and of racemic compounds based on these considerations are given, and some of the properties of the two classes of substances are then discussed. It is pointed out that the melting point of an externally compensated substance does not afford conclusive evidence as to its nature at ordinary temperatures, inasmuch as changes in crystalline form frequently occur with a change in temperature, and a mere mixture may become a racemic compound, and *vice versa* before the melting point is reached; numerous experiments are quoted in support of this view. It is also concluded that solubility determinations are valueless as a means of deciding between the three classes of externally compensated substances.

The properties of a number of inactive substances described by Aschan, Emil Fischer, Liebig, Wallach, and others are briefly discussed, and reference is made to a recent paper by Walden, which deals with the characteristics of optically active and racemic compounds.

DISCUSSION.

Dr. BONE enquired what was the practical criterion between a mixture of two optically active substances and a racemic compound proper, and whether there is any difference between the readiness with which the racemic and pseudoracemic forms can be resolved.

Dr. KIPPING said that, in the majority of cases, it is very difficult to distinguish between mixtures and racemic compounds except by crystallographic examination, but Liebig's rule, that the density of a racemic compound is different from that of its optically active isomeride, if confirmed by further experimental data, might be made use of in many cases. Theoretically a racemic compound would probably be resolved into its components less readily than a pseudoracemic substance, but when using the methods at present known for the separation of externally compensated substances, it seems improbable that any general difference in this respect would be noticed.

***72. "Note on some new gold salts of the Solanaceous alkaloids."
By H. A. D. Jowett, D.Sc.**

When hyoscyne hydrobromide and auric chloride are mixed, either in concentrated, dilute, neutral or acid solution, a red precipitate is

formed which can be crystallised from a hot aqueous solution acidulated with hydrochloric acid. On analysis, the salt is found to be an additive compound of auric chloride with hyoscyne hydrobromide $[B \cdot HBr \cdot AuCl_3]$. When this experiment is conducted in the presence of a large excess of hydrobromic acid, a chocolate coloured precipitate is formed which can be recrystallised from hot dilute hydrobromic acid and forms chocolate coloured prisms, which, on analysis, prove to be the auribromide of the base $[B \cdot HBr \cdot AuBr_3]$. Even when excess of hydrochloric acid is present the aurichloride is not formed. The analogous compounds of hyoscyamine and atropine were formed by similar reactions and resemble the corresponding salts of hyoscyne in chemical and physical properties.

Experiments were made to determine whether the bromaurichloride of formula $B \cdot HBr \cdot AuCl_3$ was an isomorphous mixture of aurichloride and auribromide, in view of the evidence adduced by Herty (*J. Am. C. S.*, xviii., 130) regarding the composition of the salt formed by mixing solutions of platinic chloride and potassium bromide ($K_2PtCl_4Br_2$). It was proved, however, that this view could not be adopted for the constitution of the gold salt, which must therefore be considered a true chemical compound.

***73. "Production of camphenol from camphor." By J. E. Marsh. M.A., and J. A. Gardner, M.A.**

The authors have described (*Trans.*, 1897, '71, 285) the production of an isomeride of camphor, camphenol. This substance was obtained by the action of strong sulphuric acid on chlorocamphene, $C_{10}H_{15}Cl$. Camphenol is produced by the action of the same reagent on camphene dichloride, $C_{10}H_{16}Cl_2$, which is the immediate product of the action of phosphorus pentachloride on camphor. The same camphenol is apparently produced from both the isomerides of the formula $C_{10}H_{16}Cl_2$, obtained from ordinary camphor, and a satisfactory yield is obtained in both cases. The action of strong sulphuric acid on other chloro-derivatives of terpenes has been examined. In particular, turpentine dihydrochloride behaves in a manner very similar to the camphor derivative, but the nature of the product of the reaction has not yet been determined.

***74. "Preliminary note on the oxidation of fenchene." By J. A. Gardner and G. B. Cockburn.**

Fenchene prepared from the fenchone of fennel oil by a modification of Wallach's method was oxidised on the water bath by moderately dilute nitric acid (1 part strong acid to 1 part water). The oxidation was complete in three days. After distilling with steam, the acid liquid

was neutralised with sodium carbonate and extracted with ether, to eliminate some insoluble oily matter. The alkaline liquid was now acidified and repeatedly extracted with ether. On evaporating the ether, a syrup was obtained which gradually crystallised. The crystals were purified from oily matter by washing with chloroform, and after recrystallisation from water melted at 207° ; they proved to consist of *cis*-camphopyric acid. The oily substance, separated by chloroform, was distilled under diminished pressure. A considerable amount of decomposition took place, and an oil and a solid distilled over. The solid was crystallised from alcohol, and proved to be camphopyric anhydride (m. p. 187°).

The yield of camphopyric acid was about 9—10 per cent. of the fenchene taken.

75. "Apiin and apigenin." By A. G. Perkin.

In a preliminary notice upon this subject (*Proc.*, 1897, 13, 53), some derivatives and decomposition products of apigenin were described; these, together with an account of further work upon this colouring matter are included in the present paper. The formation of phloroglucol and parahydroxyacetophenone, as the principal products of the gentle action of alkali upon apigenin, have been confirmed, and it is now shown that, at 200° , protocatechuic acid, parahydroxybenzoic acid, and phloroglucol are obtained in the same way. These results confirm those of Gerichten (*Ber.*, 1876, 9, 1124), except as regards the production of parahydroxyacetophenone, which is not mentioned by him. On methylation, apigenin forms a dimethyl ether, $C_{15}H_8O_3(OCH_3)_2$, yellow needles, m. p. $171-172^{\circ}$, which furnishes with alcoholic potash a potassium salt, decomposed by water, and with acetic anhydride a monacetyl derivative, $C_{15}H_7O_3(OCH_3)_2C_2H_3O$, colourless needles, m. p. $195-196^{\circ}$. The diethyl ether, $C_{15}H_8O_3(OC_2H_5)_2$, yellow needles, melts at $161-162^{\circ}$, and its monacetyl derivative, $C_{15}H_7O_3(OC_2H_5)_2C_2H_3O$, colourless needles, at $181-182^{\circ}$. As previously shown, apigenin contains 3 hydroxyl groups, consequently one is in the ortho-position to a carbonyl group. Decomposed with alcoholic potash, the dimethyl ether yields anisic aldehyde, anisic acid, and a phloroglucol derivative, ethylparahydroxybenzoic acid being formed from the diethyl ether under similar conditions.

These results, with the exception of the production of protocatechuic acid by means of alkali, point to a close relationship between apigenin and chrysin, $C_{15}H_{10}O_4$, the colouring matter of poplar buds, which yields on decomposition phloroglucol, benzoic acid, and acetophenone. It is probable that apigenin is a hydroxychrysin.

This suggested relationship is borne out by the dyeing properties of

the two colouring matters, which show a close similarity. The formation of protocathechuic acid from apigenin appears to be the result of an oxidising action, for there is no evidence of a catechol nucleus in this substance. Further experiments upon its constitution are in progress.

In the previous communication (*loc. cit.*), the author erroneously assigned the discovery of the glucosidal nature of apiin and the preparation of pure apigenin to Gerichten, instead of to Lindenhorn (*Inaug. diss. Würzburg*, 1867).

76. "Rhamnazin." By A. G. Perkin and H. W. Martin.

Rhamnazin was isolated from Persian berries by one of the authors and J. Geldard (*Trans.*, 1895, 67, 496), and shown to be a quercetin-dimethylether. The present investigation was instituted to determine the position of the methoxyl groups. On methylation, it yielded quercetintetramethylether, and from this result and other experiments described in the paper, it evidently contains no methoxyl group in the phloroglucol nucleus in the ortho-position relatively to the carbonyl group. By fusion with alkali at 200°, rhamnazin yielded phloroglucol and protocathechuic acid, and digestion with boiling alcoholic potash gave vanillin, vanillic acid, and a non-crystalline phloroglucol derivative. Oxidised by air in alkaline solution, vanillic acid and a similar phloroglucol derivative were obtained. No free phloroglucol resulted from either of these decompositions. Taking into consideration that though the dyeing properties of rhamnazin are extremely feeble it must still be considered a colouring matter, these results indicate that it has the constitution of a rhamnetinmonomethylether.

77. "Experimental verification of van't Hoff's constant in very dilute solutions. By Meyer Wilderman, Ph.D.

In van't Hoff's thermodynamic argument, the solutions are assumed to be very dilute, and the same assumption is made in the deductions from it of Planck, Riecke, Lorentz, Boltzmann, and others. The experimental verification in dilute solutions of van't Hoff's law is therefore especially important. The freezing point method has been worked out with greater accuracy for the purpose of this investigation (*Trans.*, 1895, 67, 1; Lewis, "On the Real and Apparent Freezing Point and the Freezing Point Methods," *Proc. Royal Society*, 1896; *Zeitsch. für physik. Chemie*, 1896, 19, 233).

The author has determined van't Hoff's constant in dilute solutions with thermometers graduated to $\frac{1}{100}$ th and $\frac{1}{1000}$ th of a degree respectively, simultaneously for a series of compounds, cane sugar, alcohol, urea, acetone, aniline, phenol, dextrose, resorcin, maltose, milk sugar, at

converging temperatures above and below the freezing points, using different parts of the scale of both thermometers. Small deviations only from the theoretical value of 1.87 are found, due to the different sources of experimental error, van't Hoff's constant being thus confirmed in dilute solutions.

78. "The isomeric dibromethylenes." By Thomas Gray, B.Sc.

This paper contains a record of an attempt to prepare the stereoisomeride of symmetrical dibromethylene. The following reactions are discussed: (1) the reduction of tribromomethane by sodium ethoxide; (2) the union of acetylene with bromine; (3) the reduction of acetylene tetrabromide; and (4) the addition of hydrogen bromide to bromoacetylene.

By the first of these methods, Tawildarow (*Ann.*, 1875, 176, 22) obtained, in addition to $\text{CH}_2\text{:CBr}_2$, a liquid boiling at 157° and having the formula $\text{C}_2\text{H}_2\text{Br}_2$. The author confirms the observation of Michael (*Amer. Chem. Journ.*, 1883, 5, 192), and finds that the only product of this reaction, under varying conditions of concentration, is $\text{CH}_2\text{:CBr}_2$ and he attributes Tawildarow's observation to the formation of bromoacetyl bromide by oxidation during the process of distillation.

The product of three other reactions is shown to be in every case the same symmetrical dibromethylene ($\text{CHBr}\text{:CHBr}$), boiling at 110° . The author considers that the formation of this substance by the fourth method, and the probable instability of the *cis*-modification, which should result from the second reaction, point to the formula $\begin{array}{c} \text{H} \cdot \text{C} \cdot \text{Br} \\ | \quad | \\ \text{Br} \cdot \text{C} \cdot \text{H} \end{array}$ as representing the structure of the symmetrical dibromethylene at present known.

At the next meeting, on Thursday, June 17th, there will be a Ballot for the election of Fellows, and the following Papers will be received. The authors of those marked with an asterisk have announced their intention of being present.

"The reduction of perthiocyanic acid." By F. D. Chattaway, M.A., and H. P. Stevens, B.A.

* "Molecular refraction of dissolved salts and acids." Part II. By J. H. Gladstone, D.Sc., F.R.S., and W. Hibbert.

* "On a space formula for benzene." By J. Norman Collie, Ph.D., F.R.S.

* "On the production of some nitro- and amido-oxypicolines." By A. Lapworth, D.Sc., and J. Norman Collie, Ph.D., F.R.S.

"The so-called hydrates of iso-propyl alcohol." By T. E. Thorpe, LL.D., F.R.S.

PROCEEDINGS
OF THE
CHEMICAL SOCIETY.
EDITED BY THE SECRETARIES.

No. 182.

Session 1896-7.

June 17th, 1897. Professor Dewar, F.R.S., President, in the Chair.

Mr. Samuel Pollitt was formally admitted a Fellow of the Society.

A Certificate was read for the first time in favour of Mr. Oscar Guttman, 12, Mark Lane, E.C.

The following were duly elected Fellows of the Society:—William Ackroyd; Walter Harry Barlow; William Malam Brothers; Gerald Noël Brown; Ernest Stuart Cameron; Medwin C. Clutterbuck, B.Sc., Ph.D.; William Cranfield; A. Bilderbeck Gomess; Frederick Roscoe Grundey, B.Sc.; Edward Halliwell; Frank William Harbord; Harold Harman; B. J. Harrington, Ph.D.; John Edwin Mackenzie, B.Sc., Ph.D.; William Robertson Pollock; Lionel Walter K. Scargill, B.A.; James Porter Shenton; William Taverner.

Of the following papers, those marked * were read:—

- *79. "Molecular refraction of dissolved salts and acids." Part II.
By J. H. Gladstone, D.Sc., F.R.S., and W. Hibbert.

The present paper is a continuation of a previous communication to the Society two years ago, under the same title (Proc., 1895, 11, 120). It is especially concerned in replying to the questions, "Has a salt the same molecular refraction whether it be in the crystalline state or in solution?" and "How far is any refraction change dependent on the solvent used?" The paper also gives some conclusions to which the data appear to lead.

In a table previously published (Trans., 1895, 67, 831), there were many comparisons between the specific refraction of solid salts and their value in solution, but no crystals were examined excepting those which had only one axis, or where the different indices were very near together. By adopting the method of Damien as suggested by Pope, we now add seventeen more cases having two or three indices of refraction. The observations are in accordance with the conclusions previously drawn,

the refraction of the salt in solution being in some cases greater, and in other cases smaller, than that of the crystallised body. The change of refraction however rarely, if ever, amounts to 4 per cent.

In making experiments on the effect of different solvents, we have examined nine salts and acids, including those published in 1870 (Trans., 1870, 23, 101). The first result is to show that the specific refraction of the substances dissolved in water does not generally differ much from the value yielded by solution in other solvents. If, however, we examine those substances which show a great change of refraction when deduced from different strengths of solution in water, the result is very striking. A comparison of hydrochloric acid when dissolved in water and in different alcohols and ethers, is shown in a diagram of curves. Whilst in water the specific refraction of the acid is raised in the first instance from about 0.300 to 0.386, and then gradually rises on dilution to 0.400, the acid dissolved in the different alcohols shows a lower starting point and a more gradual rise, in the following order: methyl, ethyl, amyl, and capryl alcohols; followed by a very low starting point in the case of ethyl ether, with an actual decrease on dilution, and by scarcely any change at all in the case of amyl ether.

In the case of lithium chloride, which gives in water a curve rising on dilution second only to that of hydrochloric acid itself, the solution in alcohol yields a curve very similar in character. Ferric chloride, which is the most striking instance of a great decrease in refraction occurring on dilution with water, shows also a decrease when it is dissolved in alcohol and acetic ether. Nitric acid, when mixed with water, shows a great change of specific refraction, but when dissolved in nitrobenzene shows little if any.

The authors express their growing conviction that neither the salt nor the solvent really changes its specific refraction, but that by their interaction some new product or products result, in quantities determined by the proportionate amount of the two original substances. The action may be one of dissociation or of association, or of some hitherto unrecognised redistribution. It is the changing proportion of this *tertium quid* which makes itself apparent by the changing specific refraction of the solution.

DISCUSSION.

The PRESIDENT said that the Society was much indebted to Dr. Gladstone for this last addition to his great work on the refractive indices of chemical substances. He wished it were possible to determine directly the refractive index of fluorine, which seemed, from Dr. Gladstone's results with fluorine compounds, to possess the smallest refractive power of any of the elements.

Professor DUNSTAN asked whether the authors had considered the possible influence of the formation of the alkyl chlorides on the solutions of hydrogen chloride in alcohols.

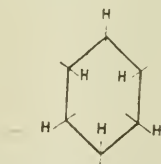
Dr. GLADSTONE, in reply, said they had been unable to detect the formation of any alkyl chloride in the solutions.

***80. "On a space formula for benzene." By J. Norman Collie, Ph.D., F.R.S.**

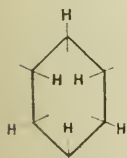
In this formula six tetrahedra (to represent the six carbon atoms) are arranged symmetrically in space equidistantly from a common centre, and so that they would occupy the six solid angles of an octahedron. They are connected also symmetrically with one another by single linkings. If the six hydrogen atoms (of benzene) are then arranged symmetrically on these tetrahedra, it will be found that there will be three on one side of the figure and three on the other side.

Movement in this arrangement might take place in two ways, a movement of each tetrahedron about its own centre, and a movement of each tetrahedron about the centre of gravity of the whole mass.

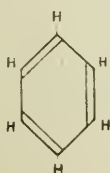
In the first case, simultaneous rotational movement of each tetrahedron about its centre would bring the combined hydrogen atoms towards the centre of the mass in *two distinct sets*; those on the 1, 3, 5 carbon atoms and those on the 2, 4, 6 carbon atoms, and a projection of this configuration might be expressed as follows:



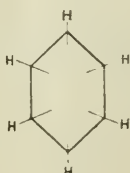
In the second case, movement about the common centre would alter the relative positions of the tetrahedra with regard to one another, bringing into play the six unsaturated points of attraction on these tetrahedra. The projection of these different phases can be represented by the following formulæ:



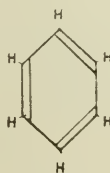
First phase.



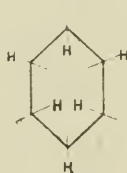
Kekulé's formula.



Centric formula.



Kekulé's formula.

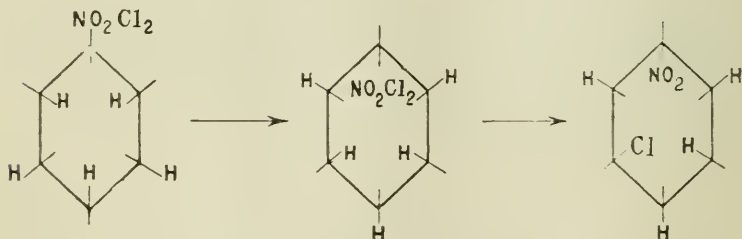


Last phase.

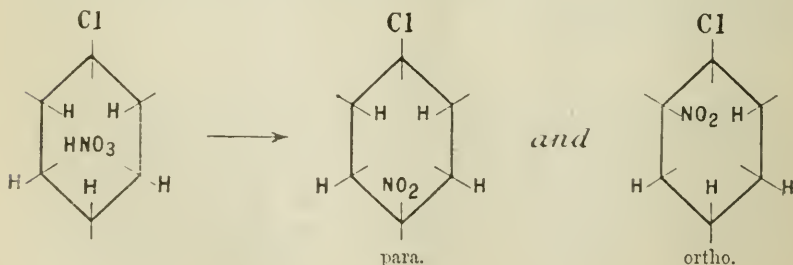
This space formula is therefore in complete accord with that of Kekulé and the centric formula, and shows how they are mutually convertible the one into the other. It also shows how the supposed double bindings in the Kekulé formula shift between the carbon atoms, thus rendering two orthochlorobenzenes impossible. But it differs from both, in that it shows how there may be two distinct sets of hydrogen atoms, and that when one set is inside the molecule, the other set is outside the molecule.

It can offer an explanation also of the fact that when one set of groups is present in a benzenoid compound, further substitution gives ortho- and para-derivatives; whilst, when another set is present, on further substitution meta-derivatives only are formed.

When chlorine acts on nitrobenzene, the chief product is metachloro-nitrobenzene. The nitro-group belongs to the group that favours the production of meta-derivatives. This nitro-group, being in a sense unsaturated, might possess a certain amount of "residual affinity" which would be sufficient to attract the entering chlorine molecule, and direct it towards the hydrogen atoms that come to the centre at the same moment that it does itself.



On the other hand, in the case of chlorobenzene, if nitric acid be allowed to react with it, no such additive compound would be produced, and the attraction of the three hydrogen atoms attached to the other three carbon atoms might just be sufficient to determine its reaction with them.



DISCUSSION.

Professor TILDEN thought the paper a valuable contribution to the theory of the construction of the benzene molecule, though he felt doubtful about the validity of the division of the substituents into saturated and unsaturated, since this distinction was, in any case, not a sharp one.

Mr. SWORN considered that the formula proposed did not differ materially from the octahedral formula of Victor Meyer and others, nor did the explanation by the law of substitution now suggested differ substantially from one proposed by himself in a paper published in the *Philosophical Magazine*.

Dr. KIPPING said he was not satisfied with the conclusion that three hydrogen atoms in benzene occupy different positions to the other three. If this were true then two monosubstitution derivatives become possible. From the readiness with which rings are formed from side groups, it would appear that the meta-position corresponds with the ortho-position.

Mr. FRISWELL said that the ordinary nitration of toluene gave a mixture of about 65 parts of orthonitrotoluene and 35 of paranitrotoluene, or very nearly 2 to 1. In conjunction with Dr. T. A. Lawson he had endeavoured to alter these proportions. Every possible variation of temperature down to nitration at or near zero or as high as 40° , every variation of nitrating mixture from large proportions of sulphuric acid to the use of nitric acid alone, every variation in the order and rate of mixture, the nitration of toluene in which paranitrotoluene had been previously dissolved, had been tried. Yet no important variation of the proportions of the two products had been produced. Mr. A. G. Green had repeated these experiments, and confirmed them. The space formula now suggested by Dr. Collie afforded an explanation, since there were two orthohydrogen atoms during the rotation postulated inside the ring, and only one parahydrogen atom in that condition. He had long considered this problem, and he had, in conjunction with Mr. C. Mills, commenced to experiment in order to ascertain whether the results might not be due to the existence of two isomeric toluenes.

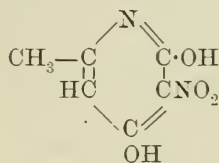
Professor COLLIE, in reply, pointed out that the space formula for benzene which he had proposed was necessarily similar in many respects to others, notably those of Vaubel and Sachse; but the point on which he wished to lay especial stress was, that there were two sets of hydrogen atoms, and that when one set was inside the molecule the other set was outside.

*81. "On the production of some nitro- and amido- oxypicolines."

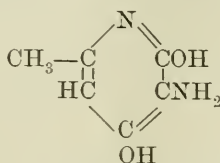
By A. Lapworth, D.Sc., and J. Norman Collie, Ph.D., F.R.S.

When dioxypicoline (Trans., 1891, 59, 617) is warmed with 60 per cent. nitric acid, a nitro-compound is at once produced, $C_6H_7NO_2 + HNO_3 = C_6H_6N_2O_4 + H_2O$. This nitrodioxypicoline possesses all the properties of a nitrophenol, it is light yellow in colour, and forms salts with bases.

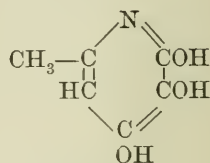
When it is carefully reduced with tin and hydrochloric acid, an amido-oxypicoline results, but should the temperature rise too high a secondary reaction occurs and a trioxypicoline is formed instead, (1) $C_6H_6N_2O_4 + 3H_2 = C_6H_6NO_2(NH_2) + 2H_2O$, (2) $C_6H_6NO_2NH_2 + H_2O = C_6H_6NO_2(OH) + NH_3$. The molecular constitution of these three compounds may be expressed by the formulæ:



Nitro-compound.



Amido-compound.



Trioxypicoline.

The amido-compound is remarkable for the series of brilliant colours it produces when treated with various oxidising agents: deep indigo-blue with ammonia and air, orange yellow with nitric acid, a deep moss green with alkaline ferricyanide of potassium, and a brilliant magenta with weak acetic acid and potassium bichromate. These colorations are very similar to those produced when various alkaloids are treated in a similar manner. This amido-oxypicoline forms salts with strong mineral acids but is also capable of liberating carbon dioxide from alkaline carbonates.

When its hydrochloride is only partially neutralised with sodium carbonate and the solution is boiled, an excessively insoluble substance separates, which seems to be a compound of the dioxamidopicoline and the trioxypicoline, $2C_6H_6NO_2(NH_2) + H_2O = C_{12}H_{13}N_3O_4 + NH_3 + H_2O$. This insoluble compound by persistent boiling with strong hydrochloric acid is finally changed into the trioxypicoline and ammonia.

The trioxypicoline may be prepared at once from the dioxamidopicoline hydrochloride, by using the full amount of sodium carbonate necessary to neutralise the hydrochloric acid, and then boiling for half an hour. It then crystallises out in long, needle-shaped crystals.

This trioxypicoline resembles pyrogallol in many of its reactions, it is an excessively powerful reducing agent, and in alkaline solution will develop photographs. It will precipitate silver from a solution

containing a considerable quantity of free nitric acid, and it also gives with oxidising agents a series of colour tests similar to those of the dioxamidopicoline.

***82. "Further experiments on the absorption of moisture by deliquescent substances." By H. Wilson Hake, Ph.D.**

In a preliminary note (Proc., 1896, 12, 33) the author showed that certain deliquescent salts, when exposed to the air, attained a maximum of hydration, and that its maximum corresponded to a definite number of molecules in a large number of cases.

In the preliminary experiments no reference was made to the vapour-pressure of water in the air, but in experiments since made, the condition of the atmosphere as regards moisture has been carefully noted, or an artificially saturated atmosphere has been contrived under known conditions of temperature.

Having now experimented with 10 deliquescent chlorides (lithium, magnesium, cadmium, calcium, copper, nickel, cobalt, iron, manganese, and platinum), 3 nitrates (sodium, magnesium, and manganese) with sulphuric acid and with sodium formate, under various conditions, it was found that (1) they attract quantities of water corresponding in all cases to a definite hydrate, (2) after deliquescing to a maximum there followed in all cases a decline in weight and in four instances the salts returned to their original hydration and crystallised out, and that (3) the amount of hydration, though apparently always corresponding to a definite number of molecules of water, is not always the same, but seems to depend within certain limits both on the temperature and the relative humidity of the atmosphere and also on the conditions under which the air has access to the salt.

The author suggests that the above experiments demonstrate the phenomenon of deliquescence to be caused by hydration of the deliquescent salt.

***83. "The fusion point, boiling point, and specific gravity of nitrobenzene." By R. J. Friswell.**

Great discrepancies are found in the books as to the above constants.

Schultz gives in his first edition, 1882, 1.2002 at 0° and 1.1866 at 14.4°; in his second edition, 1.208 at 15°. Fusion point + 3°.

Beilstein gives the same, and quotes Mitscherlich for the fusion point and Kopp for the specific gravity.

Gmelin gives 1.209 and + 3°, and quotes Mitscherlich. As to boiling points, Gmelin, quoting Mitscherlich, gives 213°, Schultz, 1882, gives

210°; in 1886, 206—207°, Beilstein quoting Städeler, 205° at 730 mm.

It would thus appear that several of these numbers have been quoted unverified for over 60 years.

No statement of specific gravity of solid nitrobenzene has been published excepting that in *Watts' Dictionary*, given to A. G. Green in a private communication by R. J. Friswell. Determinations of the various points have been made. Calculated for comparison with water at 4° the sp. grs. are:

	<i>t</i>	<i>d</i>
Solid.....	1·5	1·3440
Liquid	3·8	1·2220
„	13·0	1·2160
„	28·0	1·1931

Boiling point corrected 209·0°.

Melting and solidifying point + 5°.

Nitrobenzene is remarkable as having a distinctly coloured vapour very closely resembling that of chlorine. The colour is easily visible in a thickness of about 2 inches and is strongly marked when 6—8 inches are examined. The author is not aware of any other organic vapour of so simple a constitution which is visibly coloured.

No bands of absorption are shown in the visible spectrum when light is transmitted through this vapour. The violet and blue are absorbed as with the fluid but less strongly.

***84. "The action of light on a solution of nitrobenzene in concentrated sulphuric acid." By R. J. Friswell.**

Nitrobenzene is, as has long been known, readily soluble in concentrated sulphuric acid of 1·84 sp. gr. and upwards, but a comparatively small amount of dilution precipitates it and at about 1·7 the solubility is very slight.

When a solution in pure concentrated acid is exposed to light it slowly darkens. When exposed to direct sunlight, the darkening goes on with great rapidity, and in a few minutes the solution becomes quite black and opaque, then the action ceases. The light from burning magnesium produces the same effect.

The solution has been kept unchanged in the dark for upwards of four years. If the exposure to light takes place in a stoppered bottle, a slight odour of sulphurous acid is perceptible after some time in the air above the solution.

If the nitrobenzene thus used is recovered and redistilled and redissolved in sulphuric acid it behaves in exactly the same way.

Attempts were made to increase the change by spreading the solution on glass beads and between sheets of glass, but the depth of the colour of the product soon brought all change to an end.

Several hundred grammes of the black solution were prepared and attempts made to isolate the products of change, but though a brownish calcium salt was obtained and an ammonium salt in solution, the latter decomposed on evaporation with a caramel like odour; what was left was treated with phosphoric chloride, but no satisfactorily pure product could be obtained: the matter needs further investigation.

The rate of blackening of the solution is undoubtedly a measure of the actinic power of the light.

DISCUSSION.

Mr. A. G. GREEN remarked on the possible similarity between the action of sulphuric acid on nitrobenzene in the presence of light, and the electrolytic reduction of a solution of nitrobenzene in sulphuric acid which had been investigated by Gattermann. In this case it was shown that at first phenylhydroxylamine, then paramidophenol was the product.

Dr. HEWITT said that he had noticed that coloration occurred in sulphonating nitrobenzene, even in the dark.

The PRESIDENT drew attention to the fact that in its changes of density near its solidifying point nitrobenzene appeared to show the same peculiarity as water, viz., an enormous change, but in an opposite direction. The action of light on the nitrobenzene solution in sulphuric acid was remarkable. If a flash of magnesium light were permitted to fall on the nitrobenzene solution through a quartz window, he thought that the blackening would furnish a good lecture illustration.

Mr. FRISWELL, in reply, said that he thought it quite possible that the change in the solution of nitrobenzene in sulphuric acid when exposed to light was of the same kind as that induced by electrolysis. He had never observed any coloration on sulphonating nitrobenzene when the materials were pure and light was excluded.

85. "The reduction of perthiocyanic acid." By F. D. Chattaway, M.A., and H. P. Stevens, B.A.

The atoms forming the molecule of perthiocyanic acid have been assumed to be arranged in a simple ring from the observation that on reduction it yields thiourea and carbon bisulphide. As, however, the properties of the substance render it probable that its molecule is larger than that represented by the simplest possible formula, $\text{H}_2\text{N}_2\text{C}_2\text{S}_3$, the conclusion that in this complex molecule all the structural units have a similar atomic arrangement is only valid if the amounts of thiourea and carbon bisulphide obtained on reduction approach those given by theory. The reduction of perthiocyanic acid has therefore been carefully carried out in various ways to determine the exact amounts of carbon bisulphide and thiourea obtainable and the nature and amount of any other products of the action.

When perthiocyanic acid is reduced by tin and hydrochloric acid, carbon bisulphide and thiourea are produced in almost theoretical amount, $\text{H}_2\text{N}_2\text{C}_2\text{S}_3 + 2\text{H} = \text{CS}(\text{NH}_2)_2 + \text{CS}_2$, only very small quantities of hydrogen sulphide and carbon dioxide are produced in addition, these being doubtless formed by the hydrolysis of a small portion of the perthiocyanic acid under the influence of the hydrochloric acid, $\text{H}_2\text{N}_2\text{C}_2\text{S}_3 + 2\text{H}_2\text{O} = \text{CS}(\text{NH}_2)_2 + \text{H}_2\text{S} + \text{CO}_2 + \text{S}$.

86. "The so-called hydrates of isopropyl alcohol." By T. E. Thorpe, LL.D., F.R.S.

Four hydrates of isopropyl alcohol are stated to exist; $2\text{C}_3\text{H}_8\text{O} \cdot \text{H}_2\text{O}$, isolated by Erlenmeyer in 1863; $3\text{C}_3\text{H}_8\text{O} \cdot 2\text{H}_2\text{O}$ and $3\text{C}_3\text{H}_8\text{O} \cdot \text{H}_2\text{O}$, discovered by Linnemann in 1865; and $\text{C}_3\text{H}_8\text{O} \cdot \text{H}_2\text{O}$, prepared by Ruhemann and Carnegie in 1888. All these hydrates boil within a comparatively small range—from 78° to 81° —whereas the amount of water they contain varies from 9 to 23 per cent.

The author gives reasons for doubting the existence of these hydrates as distinct chemical entities capable of definite isolation. By studying the behaviour of mixtures of isopropyl alcohol and water, it would appear that within certain fairly wide limits, water and the alcohol distil together in indefinite proportions, and that the water tends to pass over more rapidly than the alcohol, and hence is found in the largest proportion in the fractions of lowest boiling point. There is no evidence for the existence of these hydrates at their respective boiling points. Nor is there any more evidence for their existence at ordinary temperatures.

By synthetically forming them by the direct addition of the required amount of water to the alcohol, and allowing them to partially evaporate at the ordinary temperature of the air, it is found that the alcoholic strength of the residue is greatly increased; or, in other words, the water evaporates faster than the alcohol, although the latter boils 20° lower than the former. The two substances, therefore, are not in stable union, even at ordinary temperatures.

When the relative densities of the synthetically formed 'hydrates' are plotted in terms of the amount of water they contain, the values are found to lie on what is practically a straight line; or, in other words, the density of the mixture is, within the limits studied, very nearly a linear function of the amount of the constituents.

87. "The carbohydrates of the cereal straws." By C. F. Cross, E. J. Bevan, and Claud Smith.

This paper deals with the results of further investigations of the products of acid hydrolysis of the cereal straws and of the celluloses

isolated from them, including also the closely related esparto-cellulose. The results confirm those previously communicated (Trans., 1896, 69, 804—818), that the furfural-yielding constituents (furfuroids) are selectively attacked and for the most part (90 per cent.) dissolved; also from the exceptionally high numbers for cupric reduction, that they must exist in solution in a fully hydrolysed form (monoses).

The solutions when neutralised ferment with yeast; carbonic acid and alcohol are produced, and a proportionate effect upon the constants of the solution is shown (density, opticity, cupric reduction, and furfural). Under the conditions, the proportion of the celluloses fermented amounts to 30 per cent. of the total dissolved solids. Similar conclusions are deducible from a recent paper by Tollens (*J. für Landw.*, 1897, 106—107), in which the fate of malt-furfuroids in beer-fermentations is discussed. The experimental numbers in this paper show the disappearance of a large proportion of these constituents in the process.

Since the pentoses entirely resist alcoholic fermentation, as shown by Tollens (*Kohlenhydrate*, ii), and further confirmed by the authors, as well as by later observations of Tollens privately communicated, it is evident that the group of furfuroids thus fermented is constitutionally distinct from the pentoses.

Incidentally to observations on alcoholic fermentation with mixtures of known hexoses and pentoses, the authors find that the latter remain unaffected in presence of hexoses undergoing fermentation. Under certain conditions, however, the pentoses are removed from solution by the yeast organism; the necessary condition appears to be that of "starvation," in the sense, *i.e.*, of the absence of hexoses. The disappearance of the pentose under these conditions is indicated by determinations of furfural and the fall of the furfural numbers. This phenomenon appears to be the simple one of assimilation by the yeast organism, as shown by Bokorny (*Dingl. J.*, 1897, v, 303). The pentose undergoes constitutional change in such assimilation, as the yeast shows no increase in its normal small furfural number.

The authors further discuss the question of the constitution of furfuroids thus shown to yield to alcohol on fermentation, and conclude that the hypotheses of the existence of methylene ethers of the pentoses, or pentose formals, affords, up to the point arrived at, a consistent view of their differentiation from the pentoses.

The history of "piperonal," $\text{C}_6\text{H}_5 \begin{array}{c} \diagup \text{O} \diagdown \\ \diagdown \text{O} \diagup \end{array} \text{CH}_2$, is cited in explanation

of the exceptional difficulty of arriving at positive final proof of the analogous constitutional formula $\text{C}_5\text{H}_8\text{O}_3 \begin{array}{c} \diagup \text{O} \diagdown \\ \diagdown \text{O} \diagup \end{array} \text{CH}_2$, which sums up the

above hypothesis in relation to the group of furfuroids in question. The instability of the pentose as compared with the aromatic residue prevents the application of reactions of resolution (Fittig) or synthesis (Wegscheider) such as have established the methylenic constitution of piperonal.

88. "Studies on the constitution of tri-derivatives of naphthalene No. 16. Conversion of chloronaphthalenedisulphonic acids into dichloronaphthalenesulphonic acids." By Henry E. Armstrong and W. P. Wynne.

In the course of their studies of naphthalene derivatives, the authors have had occasion to make great use of phosphorus pentachloride as an agent for displacing the SO_3H radicle by chlorine. It was therefore necessary to establish in every possible way the validity of this method of determining constitution in the naphthalene series, as it is obvious that the occurrence of isomeric change in any one case would materially weaken the force of all arguments based on its application.

With regard to the nature of the interaction, it is to be noted that, in a previous communication (Proc., 1895, 11, 83), it has been shown that it is usually possible to dispense with the pentachloride, and to obtain the chloronaphthalene corresponding with the given sulphonic chloride by merely heating the latter alone under appropriate conditions, but that as a rule the chloronaphthalene is obtained somewhat more readily and in larger relative amount when the pentachloride is used. In other words, the main function of the pentachloride is to promote the elimination of SO_2 from the SO_2Cl radicle.

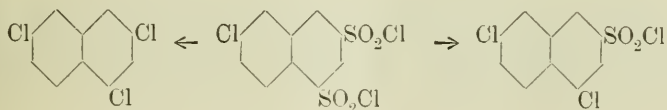
In the case of the chloronaphthalenesulphonic chlorides, the amount of dichloronaphthalene obtained by means of phosphorus pentachloride is relatively considerable, and the residue left after its removal from the crude product by distillation with steam yields nothing but the original chloronaphthalenesulphonic acid on hydrolysis.

The chloronaphthalenedisulphonic chlorides, however, behave somewhat differently, affording but a comparatively poor yield—rarely exceeding 30 per cent. of the theoretical amount—of trichloronaphthalene.

While preparing a full account of their work, the authors have felt it to be incumbent on them to thoroughly examine the residues left after separating the trichloronaphthalenes, which they have had occasion to produce on a large scale (Proc., 1895, 11, 86). Although, in view of the uniformity of the end-products, it was improbable that any change in orientation had taken place at the somewhat high temperatures at which the interactions were effected, it was obviously important to ascertain in every possible way whether such was the fact.

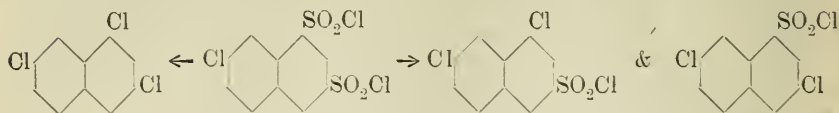
The results to be recorded are of interest, as they serve in every case to justify the conclusion previously arrived at, that the treatment of sulphonic chlorides with phosphorus pentachloride may be thoroughly trusted as a means of determining constitution in the naphthalene series. Two cases may be quoted as typical of the behaviour of chloronaphthalenedisulphonic chlorides in general.

When 2-chloronaphthalene 4':2'-disulphonic chloride (Proc., 1890, 6, 129) is heated with the theoretical quantity of phosphorus pentachloride at 175° during 2 hours, it yields both 2:4':2'-trichloronaphthalene and 2:4'-dichloronaphthalene-2'-sulphonic chloride in about equal proportions, about 50 per cent. of the material remaining unchanged. 2:4'-Dichloronaphthalene-2'-sulphonic acid affords a sparingly soluble *barium* salt, crystallising with $3\frac{1}{2}$ molecular proportions of water in microscopic needles; a sparingly soluble *potassium* salt, containing $1\frac{1}{2}$ molecular proportions, in thin scales; a *chloride* crystallising from benzene in small prisms melting at 156°; an *amide* crystallising from dilute alcohol in slender needles melting at 196°; and when the chloride is heated at 180—185° with phosphorus pentachloride it is converted into 2:4':2'-trichloronaphthalene. On hydrolysing the chloride in sealed tubes with concentrated muriatic acid at 290°, or the potassium salt with a mixture of sulphuric and phosphoric acids and superheated steam, 2:4'-dichloronaphthalene is obtained. The course of change may therefore be thus represented:



When 2-chloronaphthalene-1':3'-disulphonic chloride (Proc., 1890, 6, 13) is similarly heated with phosphorus pentachloride, it yields, besides 2:3':1'-trichloronaphthalene, a somewhat larger proportion of a mixture of 2:1'-dichloronaphthalene-3'-sulphonic and 2:3'-dichloronaphthalene-1'-sulphonic (Proc., 1890, 6, 84) chlorides, about 50 per cent. of the material remaining unchanged. 2:1'-Dichloronaphthalene-3'-sulphonic acid, the isomeride present in the larger proportion, yields an anhydrous *potassium* salt, crystallising in thin, elongated scales, but exhibiting a tendency to separate in a gelatinous form; a *chloride* crystallising from benzene and light petroleum in small prisms melting at 130°; and an *amide* crystallising from dilute alcohol in slender needles melting at 218°. When the chloride is heated at 180—185° with phosphorus pentachloride, 2:1':3'-trichloronaphthalene is formed. On hydrolysing the chloride in sealed tubes with concentrated muriatic acid at 290°, or the potassium salt mixed with sulphuric and

phosphoric acids, in superheated steam, 2:1'-dichloronaphthalene is obtained. The course of change may therefore be thus represented:



The other α - β -disulphonic chlorides behave similarly, the tendency being, however, as in the first of the above instances, to form only one of the two possible isomeric dichloronaphthalenesulphonic chlorides, no doubt because the SO_2 of the SO_2Cl radicle, like the SO_3H radicle, is more easily displaced from α - than from β -positions. It is not certain that these products are intermediate in the strict sense of the term, as the effect of prolonging the heating with phosphorus pentachloride at the minimum temperature at which the reaction takes place serves only to increase the yield both of the dichloro- and trichloro-derivatives. As the dichloronaphthalenesulphonic chlorides produced in these interactions decompose at temperatures a few degrees higher— 10° to 15° in most cases—than those at which the corresponding chloronaphthalenedisulphonic chlorides from which they are obtained undergo change, it is not difficult to understand why they escape attack by phosphorus pentachloride under the conditions observed.

89. "Conversion of 1:1'- into 1:4'-dichloronaphthalene by hydrogen chloride. The products of hydrolysis of 1:1'-dichloronaphthalene-3-sulphonic acid." By Henry E. Armstrong and W. P. Wynne.

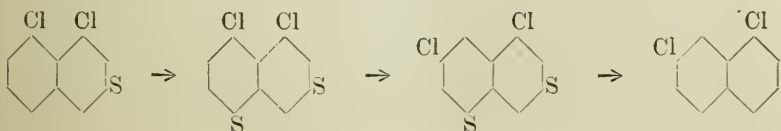
When 1:1'-dichloronaphthalene is heated with concentrated muriatic acid at 290° , it is wholly converted, save for a trace of carbonisation, into the isomeric 1:4'-dichloronaphthalene. This remarkable isomeric change does not seem to occur at temperatures below 200° , but is noticeable at 250° , and complete at 290° ; it does not occur when 1:1'-dichloronaphthalene is heated either alone, or with water, or with concentrated phosphoric acid at 300° , but does happen when it is heated with sulphuric acid of a strength to cause considerable carbonisation. None of the isomeric dichloronaphthalenes show any tendency to change under these conditions.

The experiments which led to these results were made in consequence of the perplexing behaviour of 1:1'-dichloronaphthalene-3-sulphonic acid on hydrolysis. The isomeric α -sulphonic acid (Proc., 1890, 6, 81) requires only a temperature of 230° to effect its hydrolysis, and gives only 1:1'-dichloronaphthalene, whatever be the hydrolytic agent used; the β -sulphonic acid, on the contrary, is not hydrolysed below 285° , and

according to the agent used gives one or other of no less than three dichloronaphthalenes.

1:1'-Dichloronaphthalene-3-sulphonic acid is obtained in addition to about an equal proportion of 1:1':3-trichloronaphthalene when 1-chloronaphthalene-1':3-disulphonic chloride (Proc., 1890, 6, 16) is heated with phosphorus pentachloride at 160° (compare preceding abstract). It forms a sparingly soluble, anhydrous *potassium* salt crystallising in thin, elongated scales; a *chloride* crystallising from benzene in thin scales melting at 158°; an *amide* crystallising from dilute alcohol in short, slender needles melting at 197°; and 1:1':3-trichloronaphthalene when its chloride is heated either with phosphorus pentachloride at 170°, or alone at 200—230°. On hydrolysing the potassium salt with dilute acids such as 1 per cent. sulphuric acid or 50 per cent. phosphoric acid at 290°, about 5—10 per cent. of the theoretical quantity of 1:1'-dichloronaphthalene is obtained, the residue being unchanged salt—a result by which the constitution of the acid is determined beyond doubt. When heated with 5 per cent. sulphuric acid or 60 per cent. phosphoric acid, carbonisation largely occurs, and with these and stronger acids a small amount of 1:4'-dichloronaphthalene is the only substance obtained, a better yield—some 20 per cent. of the theoretical—being got when the chloride is heated with concentrated muriatic acid at 290°. The production of 1:4'- instead of the expected 1:1'-dichloronaphthalene under these conditions is to be referred to the action of hydrogen chloride, either present or formed during the carbonisation of the salt.

On effecting hydrolysis by heating the potassium salt, mixed with sulphuric and phosphoric acids, in superheated steam instead of in sealed tubes, an unexpected result was obtained, pure 1:2'-dichloronaphthalene, to the extent of 40 per cent. of the theoretical amount, being the product, the remainder of the salt being carbonised. The explanation of this change has yet to be given. It is certain that the 1:2'-compound is not an intermediate step in the conversion of 1:1'- into 1:4'-dichloronaphthalene during hydrolysis in sealed tubes, both because it is unaffected by prolonged heating with concentrated muriatic acid, and because 1:2'-dichloronaphthalene-3-sulphonic acid cannot be detected in the material which has escaped hydrolysis, and, moreover, behaves normally on hydrolysis (compare preceding abstract). It is possible that, under the conditions specified, further sulphonation may precede hydrolysis, and that in consequence of the transference of chlorine to the para-position being thereby prevented, 1:2'-dichloronaphthalene is formed, thus:



Further experiments are being made to test this view.

Of the trichloro-naphthalenes, the 1:2:8-modification is the only one which undergoes change when heated with concentrated muriatic acid. Its sulphonic and disulphonic acids behave similarly, but the course of the action has not yet been worked out, owing to want of material.

90. "Note on the formation of diacetanilide." By George Young, Ph.D.

The introduction of a second acetyl group into acetanilide has been described in recent years by several authors. Kay (*Ber.*, 1893, 26, 2853) treated acetanilide with acetyl chloride at 170—180° from 3 to 4 hours. Bistrzycki and Ulfers (*Ber.*, 1894, 27, 91) heated a mixture of acetanilide and acetic anhydride, under pressure, 8 to 10 hours at 200—205°. Blacher (*Ber.*, 1895, 28, 2356) boiled sodio-acetanilide suspended in xylene with acetic anhydride. Tassinari (*Gazz.*, 1894, 24, i, 61) acted with acetyl chloride on sodio-acetanilide suspended in benzene. The English and German abstracts of Tassinari's paper state that this author also prepared diacetanilide by treatment of acetanilide with acetic anhydride, but the following quotations from the original paper show that the method used consisted in boiling a mixture of acetanilide, acetic anhydride, and sodium acetate on a reflux apparatus for some hours. In the introduction to his paper, Tassinari makes the general statement, "le diacidanilidi si formano anche con anidride acetica ed acetato sodico a ricadere." It is true that in describing the preparation of diacetanilide, he does not mention sodium acetate—"Trattando dell' acetanilide con anidride acetica, come è detto sopra per la formanilide . . .," but the passage referred to runs: "Scaldando a ricadere per alcune ore un misto di formanilide, anidride acetica, ed acetato sodico. . . ." Further, in a later paper (*Gazz.*, 1894, 24, i, 444) in which the work of Bistrzycki and Ulfers is quoted, no notice is taken of a statement by these authors (*loc. cit.*) that, although acetanilide undergoes some change when boiled for 2 hours with acetic anhydride, they were unable to obtain any pure product from the reaction.

The introduction of the second acetyl group takes place much more easily than might be imagined from the results quoted. If acetanilide be boiled with 2 to 3 times its weight of acetic anhydride for half an hour, over 75 per cent. is converted into the diacetanilide, which may be easily purified by the following method. The cooled product is shaken with benzene and sodium carbonate solution. After drying over calcium chloride, the benzene solution is distilled as far as possible on the water bath, and the residue treated with light petroleum. The unchanged acetanilide is removed by filtration, and the filtrate evapo-

rated. The residue solidifies on cooling to a crystalline mass, melting at 37—38°. A single recrystallisation, by extraction with cold light petroleum and evaporation of the extract, is sufficient to purify it for analysis, when it melts sharply at 38°.

0.1792 gave 0.4449 CO_2 and 0.1025 H_2O . $\text{C} = 67.71$; $\text{H} = 6.35$ %.

$\text{C}_6\text{H}_5\text{N}(\text{COCH}_3)_2$ requires $\text{C} = 67.79$; $\text{H} = 6.21$ per cent.

Part of the diacetanilide formed is probably hydrolysed by the treatment with sodium carbonate solution, but by working with not too large quantities, and performing the purification as rapidly as possible, a yield equal to the weight of acetanilide taken may easily be obtained.

91. "Derivatives of phenetol azo-phenols." By J. T. Hewitt, M.A., D.Sc., Ph.D., T. S. Moore and A. E. Pitt.

One of the authors has shown (*Ber.*, 1895, 28, 799) that certain substitution derivatives of benzeneazophenol can form addition products with half a molecule of water, differing very sharply in colour and other physical properties from the corresponding anhydrous compounds. In order to obtain further knowledge of this subject, various series of substituted benzeneazophenols are being prepared and examined. This communication deals with ortho- and para-phenol azophenols, $\text{C}_2\text{H}_5\text{O} \cdot \text{C}_6\text{H}_4 \cdot \text{N} : \text{N} \cdot \text{C}_6\text{H}_4\text{OH}$, the examination of the meta-derivative being deferred. When a paraoxyazo-compound does form an addition product with water, the addition of the latter can be most frequently brought about by dissolving the azo-compound in benzene and precipitating it by gaseous hydrogen chloride as a hydrochloride of the general formula, $\text{X} - \text{N} : \text{N} \cdot \text{C}_6\text{H}_4\text{OH} \cdot \text{HCl}$, and decomposing this with water. Frequently the molecule of hydrogen chloride is thus replaced by a half molecule of water.

Orthophenetolazophenol was prepared according to the method given by Jacobson and F. Meyer (*Annalen*, 1895, 287, 213). The melting point was found to be 128° C. (corr.), Jacobson gives 131° C. The *hydrochloride* melted between 124° and 129° C. On decomposition with water, the azophenol was regenerated; after air drying it melted at 127—128°. It may be assumed that no water had been added. In order to further characterise the azophenol, the two following derivatives were prepared.

Orthophenetolazophenylbenzoate, $\text{C}_2\text{H}_5\text{O} \cdot \text{C}_6\text{H}_4 \cdot \text{N} : \text{N} \cdot \text{C}_6\text{H}_4 \cdot \text{O} \cdot \text{COC}_6\text{H}_5$ light scarlet needles, m. p. 98° (corr.). *Orthophenetolazophenylbenzene sulphonate*, $\text{C}_2\text{H}_5\text{O} \cdot \text{C}_6\text{H}_4 \cdot \text{N} : \text{N} \cdot \text{C}_6\text{H}_4 \cdot \text{O} \cdot \text{SO}_2\text{C}_6\text{H}_5$, brilliant red needles, m. p. 83° (corr.).

Paraphenetolazophenol has been prepared by Riedel (*D. R. P.*, 48, 453), and also by Jacobson and F. Meyer (*Ann.*, 1895, 287, 215). The former gives the melting point as 104.5° C., the latter as 125—126°. The method of the latter chemists was used to prepare the compound.

The melting point was found to be 125° (corr.). The *hydrochloride* gave no very sharp melting point, beginning to melt at 131° , fusion not being complete until 154° . On treatment with water, a pale yellow powder is obtained melting at about 100° . The same substance may also be obtained by dissolving phenetolazophenol in glacial acetic acid, adding fuming hydrochloric acid, and pouring into water. After careful drying in air the substance melted at $104\text{--}109^{\circ}$ C. Apparently this substance consists of equimolecular proportions of water and paraphenetolazophenol.

	Calc. $\text{C}_{14}\text{H}_{14}\text{N}_2\text{O}_2\cdot\text{H}_2\text{O}$	Found.	Mean.
C	64.62	65.10 64.49 64.39	64.68
H	6.15	6.40 6.29 5.95	6.21

The following derivatives of paraphenetolazophenol have been prepared.

Paraphenetolazophenyl acetate, $\text{C}_2\text{H}_5\text{O}\cdot\text{C}_6\text{H}_4\cdot\text{N}:\text{N}\cdot\text{C}_6\text{H}_4\cdot\text{O}\cdot\text{COCH}_3$, yellow leaflets, m. p. 118° (corr.). *Paraphenetolazophenyl benzoate*, $\text{C}_2\text{H}_5\text{O}\cdot\text{C}_6\text{H}_4\cdot\text{N}:\text{N}\cdot\text{C}_6\text{H}_4\cdot\text{O}\cdot\text{COC}_6\text{H}_5$, small reddish brown crystals, m. p. 126° (corr.).

Paraphenetolazophenylbenzene sulphonate, $\text{C}_2\text{H}_5\text{O}\cdot\text{C}_6\text{H}_4\cdot\text{N}:\text{N}\cdot\text{C}_6\text{H}_4\cdot\text{OSO}_2\text{C}_6\text{H}_5$, large, pale yellow plates, m. p. 104° (corr.).

92. " δ -Ketopinic acid and camphoic acid." By W. S. Gilles and F. F. Renwick.

In the description first given of ketopinic acid (*cf.* Armstrong, Trans., 1896, 69, 1397), it was stated that the acid was optically inactive, even when prepared by oxidising the most active chloro-camphydrene (pinene hydrichloride) obtainable. As it was a matter of importance to determine whether the inactivity was an inherent property or due to compensation, the authors have applied Pasteur's method, and have succeeded in separating a dextrorotatory modification by fractionally crystallising the mixture of salts obtained by combining the inactive acid with strychnine. δ -Ketopinic acid has the same melting point as the "inactive" acid from which it is separated.

In their previous note (Proc., 1897, 14, 64) the authors have stated that when ketopinic acid is oxidised by permanganate it is converted into a tribasic acid resembling the camphoic acid described by Marsh and Gardner; they are now able to state that the product is camphoic acid, having obtained from it the *cis*- and *trans*-camphopyric acids and camphopyric anhydride of these chemists.

An amount of camphoic acid equal to 80 per cent. of the weight of the acid oxidised may be obtained by boiling ketopinic acid with a solution containing 50 per cent. of nitric acid and adding small quantities of stronger acid ($d=1.42$) from time to time, as the action proceeds.

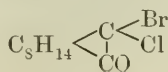
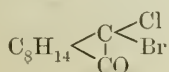
The authors will endeavour to ascertain if pinophanic and camphoic acids also exist in optically active forms, and what is the behaviour of active ketopinic acid on oxidation. Acids which are probably *cis*- and *trans*- forms of pinophanic acid have already been obtained.

93. "Note on stereoisomeric di-derivatives of camphor, and on nitrocamphor." By T. M. Lowry, B.Sc.

Having learnt from Dr. Armstrong that, in the course of his early studies of camphor derivatives, he had observed that the substances obtained on the one hand by chlorinating bromocamphor and on the other by brominating chlorocamphor are apparently different, the author has submitted the two products to examination.

Brominated chlorocamphor, according to Cazeneuve, melts at 51.5° . The author finds that, on warming a mixture of chlorocamphor and bromine and once crystallising the product from spirit, well-defined crystals are obtained which melt at $53-55^{\circ}$; on analysis, these give results showing them to be bromo-chlorocamphor. By repeated recrystallisation from a variety of solvents, this product, however, may be resolved into two fractions, alike in composition, but widely different in specific rotatory power. The less soluble product, after being twenty-five times recrystallised, fused at 61° ; its specific rotatory power was $[\alpha]_D = 16^{\circ}$. The more soluble fraction—obtained by evaporating the mother liquor, distilling the residue with steam and recrystallising the product from dilute spirit—fused at 55° ; its specific rotatory power was $[\alpha] = 63.9^{\circ}$.

On directly chlorinating bromocamphor, an oil was obtained which could not be caused to crystallise; but a crystalline chlorinated bromocamphor was obtained without difficulty by heating bromocamphor with sulphuryl chloride at 130° . After being twice crystallised from spirit, the product fused at 56° ; its specific rotatory power was $[\alpha]_D = 25.7^{\circ}$ instead of 51° —the value observed in the case of the corresponding product from chlorocamphor. As in the former case, by repeatedly recrystallising this product, a less soluble fraction was separated melting at 61.5° , the specific rotatory power of which was $[\alpha]_D = 10.3^{\circ}$; the more soluble fraction from the mother liquor had the specific rotatory power $[\alpha]_D = 28.3^{\circ}$. There can be no doubt that the two products examined were *isomorphous mixtures* of constituents differing slightly in solubility but widely in specific rotatory power, careful study of the crystalline properties showing the constants to be nearly identical in the two cases. As both yield nothing but ordinary chlorocamphor on reduction, it follows that, in each case, the apparently simple product is a mixture of the two stereoisomeric *aa*-chlorobromocamphors:



These observations, in fact, undoubtedly afford the proof hitherto wanted, that in the ordinary derivatives of camphor containing halogens, the halogen atoms are both associated with the same carbon atom.

A careful examination both of ordinary dibromocamphor and of nitro-bromocamphor has also been made, the result of which is that neither of these is resolvable into isomorphous constituents.

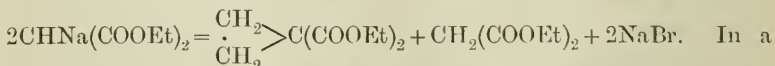
The author finds that when nitrobromocamphor is reduced by means of an alcoholic solution of potash, a nitrocamphor is obtained which has the properties attributed by Cazeneuve to that prepared from nitrochlorocamphor; the substance obtained by R. Schiff must have been impure. By the action of bromine on nitrocamphor dissolved in acetic acid, bromonitrocamphor is reproduced—not the compound $C_{30}H_{43}Br_2N_3O_{11}$, which, according to Schiff, is obtained on subjecting the potassium salt of nitrocamphor to the action of bromine.

Nitrocamphor appears to be a birotatory substance, its rotatory power in solution diminishing to a considerable extent as time proceeds—thus, a solution in benzene containing 10 per cent. of the substance, gave as initial value $[\alpha]_D = -112.4^\circ$, but after 3 hours -102.7° , and at the expiry of 22 hours, when the rotatory power no longer changed, -86.5° .

A further observation of interest has been made, viz., that when a solution of nitrocamphor in benzene is evaporated on the water bath, and the residue is further heated during about an hour, a product is obtained which is less soluble than the original nitrocamphor, and which melts at 190° instead of at 103° . The same substance is formed on heating fused nitrocamphor slightly above its melting point. The specific rotatory power of this substance in benzene (a 5 per cent. solution) is $[\alpha]_D = +187^\circ$, and in chloroform $+167^\circ$.

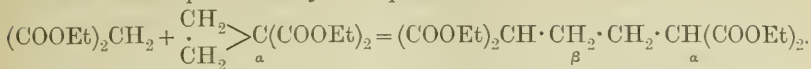
94. "The interaction of ethylene dichloride and ethylic sodio-malonate." By Bevan Lean, D.Sc., B.A., and Frederic H. Lees.

It has been shown by Prof. Perkin that, when ethylene dibromide is acted on with ethylic sodiomalonate, the chief product is 1:1-ethylic trimethylene dicarboxylate ($208-210^\circ$, 760 mm.), thus: $\begin{array}{c} CH_2Br \\ | \\ CH_2Br \end{array} +$



later paper, he has shown that a small quantity of an oil of high melting point is formed, viz., ethylic butanetetra-carboxylate (b. p. 240° , 40 mm.), and he has represented the action thus: $2(COOEt)_2CHNa + BrCH_2 \cdot CH_2Br = (COOEt)_2CH \cdot CH_2 \cdot CH_2 \cdot CH(COOEt)_2 + 2NaBr$. In later papers, he has shown that by substituting ethylene chloride for ethylene bromide the yield of ethylic butanetetra-carboxylate can be

materially increased, and it has been proved by Bone and Perkin that the action is represented by the equation



The authors now show that at the same time small quantities of *ethylic butanetricarboxylate*, $(\text{COOEt})_2\text{CH} \cdot \text{CH}_2 \cdot \text{CH}_2 \cdot \text{CH}_2 \cdot \text{COOEt}$ (b. p. 200—205°, 40 mm.) and *ethylic adipate* (b. p. 245°, 760 mm.) are formed. They attribute the formation of these two substances to the action of sodium ethoxide (or perhaps sodium hydroxide, since the materials cannot be entirely free from moisture) upon ethylic butanetetracarboxylate. It cannot be doubted that a similar action is of frequent occurrence, in greater or lesser degree, whenever substances containing two alkylic carboxylic groups attached to one carbon atom are treated with haloid compounds in the presence of sodium ethoxide. The following derivatives have been obtained from ethylic butanetricarboxylic acid. *Ethylic α-ethylbutanetricarboxylate*, $(\text{COOEt})_2\text{C}(\text{Et}) \cdot \text{CH}_2 \cdot \text{CH}_2 \cdot \text{CH}_2 \cdot \text{COOEt}$, a colourless oil, b. p. 200—202°, 32 mm. Montemartini (Abstr., 1897, 72, 19), has also prepared it; he gives the b. p. 205—208° at 35 mm. *α-Ethylbutanetricarboxylic acid*, $(\text{COOH})_2\text{C}(\text{Et}) \cdot \text{CH}_2 \cdot \text{CH}_2 \cdot \text{CH}_2 \cdot \text{COOH}$, white crystals, m. p. 155—158°. Montemartini describes it as an oil. *α-Ethyladipic acid*, $\text{COOH} \cdot \text{CH}(\text{Et}) \cdot \text{CH}_2 \cdot \text{CH}_2 \cdot \text{CH}_2 \cdot \text{COOH}$, white crystals, m. p. 48—50° (Montemartini, 46—49°).

95. "Hexanaphthene and its derivatives. Preliminary note." By Emily C. Fortey, B.Sc.

In view of work now being carried on with respect to the naphthenes (Markownikoff, *Ber.*, 1897, 30, 974, 1211, &c.; Zelinsky *Ber.*, 1897, 30, 387, 1532), the author wishes to give a short account of some results as yet incomplete on hexanaphthene and its derivatives.

The substance was obtained from American light petroleum by fractional distillation with the aid of a long fractionating column made by Professor Sydney Young, and precisely similar to the one described by him (*Chem. News*, 1895, 71, 177). Benzene and toluene were removed by prolonged treatment with a mixture of strong nitric and sulphuric acids. The hydrocarbon finally obtained (after 33 distillations) was not quite free from paraffins, but the purest fraction which boiled at 80·55—80·65° and had the specific gravity 0·7722 at 0°/0°, gave, on analysis, the following result as the mean of three determinations: C, 85·23; H, 14·60. Calculated for C_6H_{12} : C, 85·72; H, 14·28. The liquid boiling within 0·4 of a degree was chlorinated by means of a current of chlorine in presence of iron, and a mixture of di-, tri- and tetrachlorhexanaphthene was obtained. By the action of alcoholic potash on the fraction boiling at 135—140°

under a pressure of 30 mm., consisting chiefly of trichlor-hexanaphthene, hydrochloric acid was eliminated and the formation of a small quantity of benzene was proved by nitrating it and reducing the nitrobenzene to aniline, which gave the characteristic coloration with bleaching powder solution. Benzene having thus been obtained from hexanaphthene, the identity of the latter with hexamethylene is no longer questionable.

A small quantity of benzene hydrochloride, C_6H_7Cl , was also obtained by the action of alcoholic potash on trichlorhexanaphthene. It boiled at $135-140^\circ$, and an analysis gave the following result: C, 63.20; H, 5.91; Cl, 30.36. Calculated for C_6H_7Cl : C, 62.93; H, 6.12; Cl, 30.95. Hexanaphthene, when heated with fuming nitric acid, was found to be oxidised to adipic acid, as stated by Markownikoff (*Ber.*, 1897, 30, 975). As both this chemist and Zelinsky appear to have obtained methyl pentamethylene by the action of hydriodic acid on derivatives of hexanaphthene (*Ber.*, 1897, 30, 387, 1214), it became of interest to see whether the hydrocarbon itself would undergo isomeric change under similar conditions. Hexanaphthene boiling at $80.0-80.1^\circ$ was therefore heated in a sealed tube with about five times its volume of hydriodic acid, sp. gr. 1.96, and a little amorphous phosphorus. The tube was heated to about 160° for 6 hours, from 250° to 270° for 3 hours, and was maintained at about 250° for 4 hours longer. The hydrocarbon, after being washed and dried, boiled almost constantly at 80° , showing that it was unchanged hexamethylene.

Zelinsky has found that methylhexamethylene is converted into dimethylpentamethylene by heating with hydriodic acid (*Ber.*, 1897, 30, 1532), it is therefore interesting to note that hexamethylene itself appears to be much more stable than its derivatives.

It is hoped to obtain a fresh supply of the substance by the fractional distillation of Galician petroleum, when the experiments will be continued.

ADDITIONS TO THE LIBRARY.

I. *By Purchase.*

Lafar, Franz. Technische mykologie, ein handbuch der Gärungs-physiologie Erster Band. Pp. xii + 362. Jena 1897.

Saare, O. Die fabrikation der Kartoffelstärke. Pp. xii + 577. Berlin 1897.

II. *Donations.*

Bedford, the Duke of, and Pickering, S. U. Report on the working and results of the Woburn Experimental Fruit Farm since its establishment. First Report. Pp. iv + 194. London 1897.

From the Authors,

Crookshank, E. M. A Text-book of Bacteriology, including the Etiology and Prevention of Infective Diseases. Fourth edition. Pp. xxx + 715. London 1896. From the Author.

Hantzsch, M. A. Précis de Stéréochimie. Pp. 223. Paris 1896. From the Publishers.

LIBRARY.

The Library will be closed during the last fortnight in August for cleaning and the annual revision of the Catalogue. Fellows are requested to return all books in their possession not later than August 9th.

PROCEEDINGS OF THE CHEMICAL SOCIETY.

EDITED BY THE SECRETARIES.

No. 183.

Session 1896-7.

The following are the abstracts of papers received during the vacation, and published in the Transactions :—

96. "The ethers of camphoroxime." By M. O. Forster, Ph.D.

The *methyl ether* of camphoroxime boils at 181·5—182·5° under a pressure of 357 mm.; it has the sp. gr. = 0·9631, and the specific rotatory power $[\alpha]_D = -13·05^\circ$ at 20°. It does not reduce an ammoniacal solution of silver nitrate, and dissolves in mineral acids without undergoing change. The *nitrate* crystallises from benzene in needles melting at 81—82°, and has $[\alpha]_D = -16·9^\circ$ in benzene; the *hydriodide* is amorphous, and melts at 157° with vigorous effervescence.

The *ethyl ether* (Nägeli) boils at 185° under a pressure of 336 mm., and has the sp. gr. = 0·9470; the specific rotatory power $[\alpha]_D = -19·0^\circ$ at 23·5°.

The *benzyl ether* is a colourless oil, which on distillation is in part resolved into benzaldehyde and camphorimine, as represented by the equation $C_{10}H_{16} \cdot NO \cdot CH_2 \cdot C_6H_5 = C_{10}H_{16} \cdot NH + C_6H_5 \cdot CHO$; it has $[\alpha]_D = -16·4^\circ$ in alcohol, and forms an amorphous *hydriodide* which melts at 91°. Concentrated sulphuric acid resolves the ether into camphoroxime and the resinous hydrocarbon, $C_{14}H_{12}$, obtained on dissolving benzylic alcohol in concentrated sulphuric acid. Alcoholic hydrochloric acid eliminates α -benzylhydroxylamine from the ether; the *platinochloride* of this base forms golden-yellow scales, and does not melt below 250°.

The *acetyl* derivative of camphoroxime is a colourless liquid, and is completely converted into acetic acid and campholenonitrile on distillation; it has the specific rotatory power $[\alpha]_D = -45·8^\circ$ in alcohol, and on treatment with cold phenylhydrazine yields symmetrical acetylphenylhydrazine and camphoroxime.

The *benzoyl* derivative crystallises from acetone in magnificent six-sided prisms, and melts at 88—90°; it has $[\alpha]_D = -40.7^\circ$ in alcohol, and yields benzanilide when heated with aniline. Cold phenylhydrazine gives rise to benzoylphenylhydrazine and camphoroxime. *Camphoroxime hydrobromide* melts and evolves hydrogen bromide at 174°; it has $[\alpha]_D = -35.8^\circ$ in alcohol, and is converted by glacial acetic acid into campholenonitrile and hydrogen bromide. *Camphoroxime platinumchloride* crystallises in transparent prisms which become opaque in the desiccator, and melts at 156.5° with vigorous effervescence; cold water regenerates the oxime. *Inactive camphoroxime* melts like the active modification at 118°; it crystallises from petroleum in diamond-shaped plates, and is racemic according to the classification recently suggested by Kipping and Pope (this vol., 135).

97. "The action of nitrogen trioxide and tetroxide on alcohols. Part I." By Julius Berend Cohen, Ph.D., and Harry Thornton Calvert, B.Sc.

The authors have found that when nitrogen trioxide or tetroxide dissolved in chloroform is allowed to act upon benzyl alcohol, that water is in both cases eliminated, and compounds of the formula $C_6H_5CHN_2O_3$ and $C_6H_5CHN_2O_4$ are probably formed, which rapidly decompose on standing into benzaldehyde, with the separation in the first case of nitric oxide, and in the second of nitrogen trioxide, according to the following equations, (1) $C_6H_5CHN_2O_3 = C_6H_5COH + 2NO$, (2) $C_6H_5CHN_2O_4 = C_6H_5COH + N_2O_3$. The latter substance, which may be termed benzylidene nitrosate, is decomposed by water into a compound of the formula $C_7H_7NO_3$, which is probably identical with a substance obtained by Lippmann and Hawliczek (*Ber.*, 1876, 9, 1463) by the action of nitric acid upon benzaldehyde. By the action of reducing agents it is converted into benzyl alcohol, benzylamine and ammonia.

98. "The action of nitrogen tetroxide on ortho- and para-nitrobenzylalcohol." By Julius B. Cohen, Ph.D., and William H. Harrison, B.Sc.

The authors have discovered a simple method for preparing the aldehydes corresponding to ortho- and para-nitrobenzylalcohol. The reaction consists in treating the alcohol with a small quantity of nitrogen tetroxide in presence of air. A nearly theoretical yield of these aldehydes, hitherto very difficult to prepare, has been effected by this method.

99. "The action of aromatic amines upon diacetyltartaric anhydride." By Julius Berend Cohen, Ph.D., and William Hudson Harrison, B.Sc.

In attempting to prepare the isomeric toluido-acetyl tartaric acids, by acting upon diacetyltartaric anhydride with the isomeric toluidines, with a view to comparing their optical characters, the authors were unsuccessful; but obtained, on the other hand, by this reaction with different aromatic amines, a series of golden-yellow crystalline compounds. The formula of the aniline compound is probably $C_{16}H_{12}N_2O_3$, that of the paratoluidine compound $C_{18}H_{16}N_2O_3$, and of the α -naphthylamine compound $C_{27}H_{16}N_2O_3$. The constitution of these compounds has not yet been ascertained. The reaction in all cases is very complex, and the yield of the yellow substances very small.

100. "Studies on citrazinic acid. Part V." By W. J. Sell, M.A., and F. W. Dootson, B.A.

This investigation was commenced with the view of obtaining some evidence of the positions of the hydroxyl groups in citrazinic acid, by preparing the corresponding dichlorisonicotinic acid, and then replacing the chlorine atoms either by cyanogen or methyl, and thus by well-known methods obtaining one of the tricarboxy-acids whose constitution has been established. In the preparation of the dichlorisonicotinic acid by the interaction of phosphorus pentachloride on citrazinic acid, however, such a number of interesting substances were found to be produced that it was determined to publish this part of the work at once, leaving the remainder for a further communication. The following substances—amongst others—have been isolated, and are described in the paper.

(1) Chlorhydroxyisonicotinic acid; (2) dichlorisonicotinic acid; (3) tetrachlorisonicotinic acid chloride; (4) $\alpha\beta\alpha'\beta'$ -tetrachlorisonicotinic acid; (5) tetrachlorpyridine; (6) pentachlorpyridine; (7) pentachlorpicoline.

101. "The condensation of choral with resorcinol. II." By J. T. Hewitt, M.A., D.Sc., and Frank G. Pope.

In an earlier paper (Trans., 1896, 69, 1265), the view was expressed that the substance of the formula $C_{14}H_{10}O_5$, obtained by the condensation of choral hydrate with resorcinol, was a lactone of 2:4:2':4'-tetrahydroxydiphenylacetic acid. The authors had overlooked a paper by Michael and Comey (*Amer. Chem. Journ.*, 1883—4, 5, 350) in which

the formula $C_8H_6O_3$ was attributed to the compound in question. The determination of the molecular weight by the lowering of freezing point of a phenolic solution gave as result 232; the values required by the formulæ $C_8H_6O_3$ and $C_{14}H_{10}O_5$ being 150 and 258 respectively. The analyses of the acetate and benzoate have further confirmed the authors' views that the compound possesses three hydroxyl groups. In addition to this, it has been found that a red salt is precipitated when an excess of sodium ethylate solution is added to an absolute alcoholic solution of the lactone: the salt was found to contain 22.10 per cent. of sodium, whilst the formula $C_{14}H_7O_5Na_3$ requires 21.30 per cent. of sodium.

The analysis of the salt, obtained by boiling the lactone with water and barium carbonate, led to the formula $Ba(C_{14}H_{11}O_6)_2$; the soluble zinc salt obtained in a similar way, gave a percentage of zinc which agrees with the formula $Zn(C_{14}H_{11}O_6)_2$.

102. "On β -oxycellulose." By Benjamin Samuel Bull, M.A., B.Sc.

β -Oxycellulose has been studied by several workers, and Cross and Bevan have prepared a trinitro-derivative. In this paper a benzoate and nitrate obtained from β -oxycellulose are described. These compounds are probably hexa-derivatives of a substance having the empirical formula $C_{16}H_{27}O_{14}$.

103. "A new synthesis of phloroglucinol." By David S. Jerdan, B.Sc.

When finely divided sodium is dissolved in a benzene solution of ethylic acetone-di-carboxylate and the solution is boiled for some hours, a gummy deposit is slowly formed. The whole is then shaken with water and the aqueous solution, after separation of the benzene, is acidified with sulphuric acid. The solution becomes milky and a granular precipitate falls after a short time. The new substance may be recrystallised from glacial acetic acid, and then possesses a composition corresponding with the formula $C_{12}H_{10}O_7$.

This compound, when boiled with methylic alcohol containing 3 per cent. of hydrogen chloride, took up a molecule of alcohol, giving a crystalline ester, $C_{13}H_{14}O_8$. The substance $C_{12}H_{10}O_7$ must therefore be a lactone. Further, on hydrolysis with baryta solution, the lactone gave carbon dioxide, alcohol, malonic acid, and phloroglucinol. The new compound is therefore a phloroglucinol derivative.

It is probably formed according to the equation:— $2C_{10}H_{14}O_5 + 3Na = C_{12}H_{10}O_7 + 3NaOC_2H_5 + 3H$. The immediate product of the reaction must of course be a sodium derivative, the lactone $C_{12}H_{10}O_7$ being formed from this on addition of sulphuric acid.

104. "Phenanthrone." By Francis R. Japp, F.R.S., and Alexander Findlay, M.A., B.Sc.

Phenanthrone was regarded by its discoverer, Lachowicz (*J. pr. Chem.*, 1883, [2], 28, 173), as a ketone of the formula $\begin{array}{c} \text{C}_6\text{H}_4 \cdot \text{CH}_2 \\ | \\ \text{C}_6\text{H}_4 \cdot \text{CO} \end{array}$ Japp and Klingemann (*Trans.*, 1893, 63, 770) suggested that it might be a phenol of the formula $\begin{array}{c} \text{C}_6\text{H}_4 \cdot \text{CH} \\ | \\ \text{C}_6\text{H}_4 \cdot \text{C} \cdot \text{OH} \end{array}$ (*β -phenanthrol*).

In the hope of deciding between these two formulæ, the present authors have prepared various derivatives of phenanthrone. The evidence, however, points in both directions. The compound reacts both in the ketonic and in the phenolic form, although more frequently in the latter. In the great majority of its reactions it is a strict analogue of *β -naphthol*.

In preparing phenanthrone by the method discovered by Japp and Klingemann—reduction of phenanthraquinone with hydriodic acid—the authors find that two other substances are simultaneously formed: *β -phenanthrylic oxide* (C_{14}H_9)₂O (m. p. 210°), and *tetraphenylene-furfuran* $\begin{array}{c} \text{C}_6\text{H}_4 \cdot \text{C} - \text{C} \cdot \text{C}_6\text{H}_4 \\ | \quad | \\ \text{C}_6\text{H}_4 \cdot \text{C} \cdot \text{O} \cdot \text{C} \cdot \text{C}_6\text{H}_4 \end{array}$ (m. p. 306°). The latter was obtained by Japp and Klingemann by the destructive distillation of monacetyl phenanthraquinol.

Phenanthrone and *β -phenanthrylic oxide* both yield molecular compounds with picric acid, $\text{C}_{14}\text{H}_{10}\text{O} \cdot \text{C}_6\text{H}_2(\text{NO}_2)_3\text{OH}$ (m. p. 185°) and $(\text{C}_{14}\text{H}_9)_2\text{O} \cdot 2\text{C}_6\text{H}_2(\text{NO}_2)_3\text{OH}$ (m. p. 148°).

Phenanthrone, when in solution, is converted by aërial oxidation into the compound $\text{C}_{28}\text{H}_{18}\text{O}_3$ (obtained by another process by Japp and Klingemann), which crystallises in dark-red laminæ melting at 156—157°. This compound is broken up by acetic anhydride into phenanthrone and phenanthraquinone, the former undergoing acetylation. It may be synthesised by the direct union of phenanthrone and phenanthraquinone. The authors regard it as an aldol condensation compound of these two substances, and ascribe to it the constitution $\begin{array}{c} \text{C}_6\text{H}_4 \cdot \text{C}(\text{OH}) \cdot \text{CH} \cdot \text{C}_6\text{H}_4 \\ | \quad | \\ \text{C}_6\text{H}_4 \cdot \text{CO} \quad \text{CO} \cdot \text{C}_6\text{H}_4 \end{array}$. On boiling with fuming hydriodic acid, it is converted quantitatively into tetraphenylene-furfuran. Acetic anhydride converts phenanthrone into *β -phenanthrylic acetate*, $\text{C}_{14}\text{H}_9 \cdot \text{O} \cdot \text{C}_2\text{H}_3\text{O}$ (m. p. 77—78°). When heated with methylic alcohol and sulphuric acid, phenanthrone yields *methylic β -phenanthrylic oxide*, $\text{C}_{14}\text{H}_9 \cdot \text{O} \cdot \text{CH}_3$ (m. p. 96—97°). When heated with ammonia it yields a mixture of *β -phenanthrylamine*, $\text{C}_{14}\text{H}_9 \cdot \text{NH}_2$ (m. p. 139°), and *β -diphenanthrylamine*, $(\text{C}_{14}\text{H}_9)_2\text{NH}$ (m. p. 237°). With phenylhydrazine at 200° it interacts,

eliminating water and ammonia and yielding 2':3'-diphenyleneindole (m. p. 188—189°).

105. "The yellow colouring principles of various tannin matters. IV." By A. G. Perkin.

Cape sumach, the leaves of the *Colpoon compressum*, is used in South Africa as a substitute for sumach (*Rhus Coriaria*) under the name of "Pruim-bast." According to H. Procter (private communication) it contains 23 per cent. of a catechol tannin. Its dyeing property is due to the presence of a new glucoside, *osyritrin*, $C_{27}H_{30}O_{17}$, pale yellow needles, m. p. 185°, which is decomposed by acid into quercetin and glucose, $C_{27}H_{30}O_{17} + 2H_2O = C_{15}H_{10}O_7 + 2C_6H_{12}O_6$. This is not identical with *viola-quercetrin* (Mandelin, *J.*, 1883, 1369), $C_{42}H_{42}O_{24}$ which exists in the *Viola tricolor florensis*. The tannin, obtained as an orange-coloured, transparent mass, is a glucoside yielding, with acid, an anhydride or phlobophane and a sugar. By fusion with alkali, protocathechuic acid is formed. A re-examination of gambier catechu (*Ungarica Gambier*) corroborated the statement of Löwe (*Zeit. anal. Chem.*, 1874, 12, 127) that this contains quercetin. Acacia catechu not previously examined was found to contain the same colouring matter.

The dyeing properties of a commercial sample of Venetian sumach (*R. Cotinus*) are due to myricetin and not quercetin as stated by Löwe (*loc. cit.*). This result will be corroborated by the examination of a specially picked sample.

Valonia (*Quercus Ægilops*), divi-divi (*Cæsalpina Coriaria*), myrabolans (*Terminalia chebula*), agarobilla (*Cæsalpina brevifolia*), pomegranate rind (*Punica granatum*), and gall-nuts (*Quercus infectoria*), owe their tinctorial property to ellagic acid, and contain no member of the quercetin group. It is here pointed out that the plants examined hitherto contain, respectively, a tannin and colouring matter which yield on decomposition identical acids, and in some cases the same phenol.

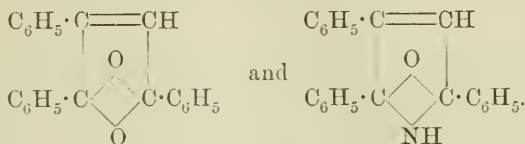
106. "Ammonia and phenylhydrazine derivatives of $\alpha\beta$ -dibenzoylcinnamene (anhydracetophenonebenzil)." By Francis R. Japp, F.R.S., and Alfred Tingle, B.Sc.

By oxidising dibenzoylcinnamenimide, $C_{22}H_{17}NO$ —the first product of the action of ammonia on dibenzoylcinnamene—with chromium trioxide, the authors have obtained a mixture of *dibenzamide*, *benzamide*, and regenerated *dibenzoylcinnamene*.

By reducing dibenzoylcinnamenimide with zinc dust and acetic acid in the cold, A. Smith's *triphenylpyrrhole*, $\begin{array}{c} \text{C}_6\text{H}_5 \cdot \text{C} = \text{CH} \\ | \quad | \\ \text{C}_6\text{H}_5 \cdot \text{C} \quad \text{C} \cdot \text{C}_6\text{H}_5 \\ | \\ \text{NH} \end{array}$, melting at

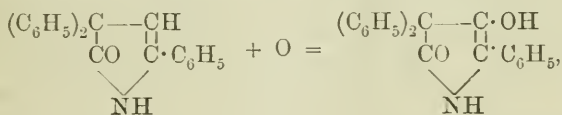
140—141° (Trans., 1890, 57, 645), is formed.

The authors discuss the various reactions of dibenzoylcinnamene and dibenzoylcinnamenimide, and ascribe to these compounds the formulæ



It seems to be impossible to assign to dibenzoylcinnamenimide, for example, any other formula which will account for the formation of dibenzamide during oxidation.

By the oxidation of triphenylpyrrholone—the transformation product of dibenzoylcinnamenimide under the influence of heat—with chromium trioxide, the authors have obtained a compound which they regard as *triphenylhydroxypyrrholone* (m. p. 168°):



or one of its possible tautomeric forms. Heated with caustic potash, this compound evolves ammonia, and yields a mixture of benzoic and benzoic acids.

The authors have also studied the destructive distillation of the compound $\text{C}_{28}\text{H}_{22}\text{N}_2$ (m. p. about 230°), obtained by Japp and Huntly (Trans., 1888, 53, 184) by the action of phenylhydrazine on dibenzoylcinnamene. They find that it yields the 1:3:4-*triphenylpyrazole* obtained by A. Smith (*Annalen*, 1896, 289, 332) by the destructive distillation of tetraphenyldihydro-1:2-diazine. They point out that result renders it very improbable that the compound $\text{C}_{28}\text{H}_{22}\text{N}_2$ has the constitution of an anilidotriphenylpyrrhole, ascribed to it by Japp and Klingemann (Trans., 1890, 57, 671).

107. "Derivatives of cotoin and phloretin." By A. G. Perkin and H. W. Martin.

A study of the acetylation of the diazobenzene derivatives of cotoin and phloretin.

Cotoin, $C_{14}H_{12}O_4$, a constituent of coto-bark, is, according to Ciamician and Silber, a monomethyl ether of benzoylphloroglucinol, $C_6H_2(OCH_3)(OH)_2 \cdot CO \cdot C_6H_5$ (*Ber.*, 1894, 27, 409). *Cotoinazobenzene*, $C_{14}H_{11}O_4 \cdot C_6H_5N_2$, forms orange-yellow needles, m. p. 183—184°. *Cotoin-azo-o-toluene*, $C_{14}H_{11}O_4 \cdot CH_3 \cdot C_6H_4N_2$, m. p. 203—204°, and *cotoin-azo-p-toluene*, m. p. 207—208°, crystallise similarly. *Diacetyl-azo-benzene cotoin*, $C_{14}H_9O_4(C_2H_3O)_2 \cdot C_6H_5N_2$, crystallises in scarlet needles, m. p. 155—156°. As with the maclurin compound (*Trans.*, 1897, 71, 186), the acetyl-groups could be determined by Liebermann's method.

Phloretin, $C_{15}H_{14}O_5$, occurs in the root bark of the apple tree as a glucoside phloridzin. According to Ciamician and Silber, it has the constitution $C_6H_2(OH)_3 \cdot CO \cdot CH(CH_3) \cdot C_6H_4 \cdot OH$. *Phloretin-disazobenzene*, $C_{15}H_{12}O_5(C_6H_5N_2)_2$, red needles, m. p. 254—256°, *phloretin-disazo-o-toluene*, m. p. 250—251°, and *phloretindisazo-p-toluene*, m. p. 250—251°, closely resemble the corresponding maclurin derivatives. *Acetyl phloretindisazobenzene*, $C_{15}H_{11}O_5(C_2H_3O)(C_6H_5N_2)$, forms orange-red needles melting at 217—219°. No higher acetyl derivative could be obtained. Comparing this result with those previously obtained with maclurin and phloroglucinoldisazobenzenes (*Trans.*, 1897, 71, 186), it would thus appear that phloretin contains only three hydroxyl groups. From Ciamician and Silber's work there appears to be no doubt, however, as to the correctness of their constitution for phloretin (*loc. cit.*). Thus, all hydroxyls in the phloroglucinol nucleus of phloretin must in diazobenzenephloretin be in the ketonic form, a peculiarity which in some way is therefore due to the influence of the phloretol group.

108. "Azobenzene derivatives of phloroglucinol." By A. G. Perkin.

Though phloroglucinol is known to yield azo- and disazo-derivatives as phloroglucinol-*p*-azobenzene sulphonic acid, $C_6H_5O_3 \cdot N_2 \cdot C_6H_4 \cdot SO_3H$ (Stebbins, *Am. Chem. Soc. J.*, 1880, 2, 240), and disazobenzenephloroglucinol, $C_6H_4O_3(N_2 \cdot C_6H_5)_2$ (Weselsky and Benedikt, *Ber.*, 1879, 12, 226), no trisazo-compounds have been previously obtained, though judging from its constitution the formation of such should be expected.

Phloroglucinoltrisazobenzene, $C_6H_3O_3(C_6H_5N_2)_3$, fine needles possessing a green iridescence which do not melt below 300°, is formed by addition of diazobenzene sulphate to a solution of phloroglucinol in aqueous sodium carbonate. Its production is independent of the amount of diazobenzene sulphate employed. It contains no free hydroxyl groups, being insoluble in alkaline solutions.

Phloroglucinol-o-trisazoanisol is prepared from [phloroglucinol and *o*-diazooanisol in either sodium carbonate or acetate solution. No

corresponding disazo-compound could be obtained in this manner. It forms maroon coloured needles melting above 300° , insoluble in alkaline solutions.

Phloroglucinol-disazobenzene-m-azonitrobenzene, obtained from phloroglucinol-disazobenzene and *m*-diazonitrobenzene, forms dull red needles, m. p. 290° .

It is proposed to study the reaction of other substituted diazobenzenes with phloroglucinol under similar conditions.

109. "The action of phosphorus pentachloride on fenchone."

By J. Addyman Gardner, M.A., and G. B. Cockburn, B.A.

Fenchone is acted on at the ordinary temperature very much more slowly than camphor, and the products of the action are different, for on pouring into water to get rid of the excess of phosphorus pentachloride and oxychloride, the authors obtained a crystalline compound of the formula $C_{10}H_{14}ClPO(OH)_2$, which they name chlorofenchone-phosphoric acid, and an oil consisting of unchanged fenchone and a substance containing chlorine, probably chlorofenchone.

Chlorofenchone phosphonic acid is a white, crystalline solid, melting at 196° . It is very soluble in ether, alcohol, chloroform, and benzene, but more sparingly soluble in water. It is a dibasic acid, and the sodium salt crystallises in white, needle-shaped crystals. The lead, barium, and copper salts are insoluble in water. The oil containing chlorine is at present under investigation.

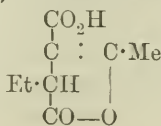
110. "Ketolactonic acid and its homologues." By C. H. G. Sprankling, B.Sc.,

In 1882, Young (Trans., 1883, 43, 172) observed that when β -ethyl-acetosuccinic ether is slowly distilled, a little alcohol is liberated and on hydrolysis of the distillate with hydrochloric acid a crystalline acid, $C_8H_{10}O_4$, is formed in addition to α -ethyl- β -acetopropionic acid and a small quantity of ethylsuccinic acid.

The barium salt, $Ba(C_8H_9O_4)_2$, is obtained by the action of barium carbonate; a cold solution of barium hydrate gives the salt of β -ethyl-acetosuccinic acid, whilst at 100° barium carbonate is precipitated and the salt of α -ethyl- β -acetopropionic acid is formed.

From its composition, method of formation and behaviour it was concluded that the crystalline acid, to which the name ketolactonic

acid was given, has the constitution



At Prof. Young's suggestion, these experiments have been repeated and a much larger yield of the crystalline acid has been obtained by prolonged heating of the β -ethylacetosuccinic ether before hydrolysis.

The lower homologues of the acid have also been prepared in a pure state from acetosuccinic ether and β -methylacetosuccinic ether respectively, and it has been found that by prolonged heating of β -isopropylacetosuccinic ether and subsequent hydrolysis with hydrochloric acid a very small quantity of the higher homologue is formed.

It is thus shown that the crystalline acid obtained by Young is the third member of a series to which the general name ketolactonic acid may conveniently be given. It will be necessary, however, to call the lowest member of the series ketolactonic acid, the others being named methyl, ethyl, isopropylketolactonic acid.

Ketolactonic acid, $C_6H_6O_4$ does not crystallise; methyl-ketolactonic acid, like the ethyl compound, forms colourless crystals, m. p. 176° .

The barium salts corresponding to those derived from the ethyl compound were prepared from ketolactonic acid and methyl-ketolactonic acid.

The rate of action of sodacetoacetic ether on the brominated fatty ethereal salts, the rate of elimination of ethyl alcohol from the β -alkylacetosuccinic ethers, and the rate of hydrolysis of the ethers differ greatly in the four cases examined, the rate in general diminishing rapidly with rise of molecular weight.

The hydrolysis of the β -alkylacetosuccinic ethers may take place in two ways—(a) the acetyl group is replaced by hydrogen and an alkylsuccinic acid is formed; (b) carbon dioxide is evolved and an α -alkyl- β -acetopropionic acid formed. With the ethers investigated, the higher the molecular weight of the alkyl group the larger is the relative yield of the alkyl succinic acid.

November 4th, 1897. Professor Dewar, F.R.S., President, in the Chair.

Messrs. Harold W. Harrie, W. R. Lang, W. H. Barlow, and A. V. C. Fenby were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. Ernest George Annis, Health Office, Town Hall, Huddersfield; William Ball, 54, Stretton Road, Leicester; Richard Oxley Burland, J.P., Poolstock House, Wigan; Alexander McLean Cameron, Daylesford, Victoria; Owen Aly Clark, 12, Abbey Gate Street, Bury St. Edmunds; Alexander Clarkson, 2, Waveney Crescent, Ballymena, Ireland; Frank Collingridge, B.Sc., Kenmore, Shepherd's Hill, Highgate, N.; James Murray

Crofts, B.A., Richleigh, Gloucester; David Crole, Primrose Studios, Wellington Square, Chelsea, S.W.; John Daniell, Council of Education Laboratory, Johannesburg, S.A.R.; Andrew James Dixon, Dapto, N.S.W.; Robert Hamilton, 11, Ibrox Place, Glasgow; John Harger, B.Sc., Ph.D., The Nook, St. James's Mount, Liverpool; Charles Kelly, Oakmere, Hawarden, Cheshire; Tom Lemmey, B.A., Wellington College, Berks; James Scott Maclaurin, D.Sc., Mount Eden, Auckland, N.Z.; Allen Macmullen, 82, James Street, Dublin; Edward Masters, The Aloes, Hinckley Road, Leicester; John A. Mathews, 4, First Place, Brooklyn, N.Y.; Philip George Gregory Moon, 129, Rosary Road, Thorpe, Norwich; Joseph John Mooney, 34, Easter Road, Edinburgh; James Charles Philip, B.Sc., Ph.D., 16A, Merton Road, Victoria Road, Kensington, W.; Alexander Ferguson Reid, Stair Bridge, Stair, Ayrshire; Ernest Henry Roberts, Hollydale, Allfarthing Lane, Wandsworth, S.W.; Edward Sydney Simpson, 34, Pier Street, Perth, West Australia; Robert Francis Woodsmith, 89, Bartholomew Close, E.C.; Frederick William Steel, Tamunua, Navua River, Fiji; Michael Edmund Stephens, Avenue House, Finchley, N.; George Stubbs, Arnside, Hertford Road, East Finchley, N.; Edward Howard Tripp, Ph.D., Kent House, Blackheath Hill, S.E.; John Scriven Turner, 20, Bury Street, Bloomsbury, W.C.; Framjee Khurshedjee Viccajee, Hyderabad, Deccan, India; Percy John Vinter, Wesley College, Sheffield; Arthur James White, Whinsfield, Barrow-in-Furness.

Sir WILLIAM CROOKES then took the Chair, and of the following papers those marked * were read:—

***111. "On the properties of liquid fluorine." By Professors Moissan and Dewar.**

The nearest approach to the properties of the mythical alkahest or universal solvent of the alchemist is to be met with in fluorine. The transparent vessels in which it can be manipulated have to be made of some fluoride like fluor-spar, and such vessels are equally difficult to construct and ill-adapted for chemical manipulation. Modern research has, however, revealed the fact that the most powerful chemical affinities are completely suspended by allowing substances to come into contact at very low temperatures, and it appeared possible that even fluorine, which has the most powerful chemical activity of all the elements, might be manipulated in glass vessels under such conditions.

In a paper communicated to this Society entitled "The Liquefaction of Air and Research at Low Temperatures" (*Proc.*, 1895,

11, 221) speaking of fluorine, the author remarked, "This is the only widely-distributed element that has not been liquefied. Some years ago, Wallach and Hensler pointed out that an examination of the boiling points of substituted halogen organic compounds led to the conclusion that, although the atomic weight of fluorine is nineteen times that of hydrogen, yet it must in the free state approach hydrogen in volatility. This view is confirmed by the specific refractive index, which Gladstone showed was rather lower than hydrogen. If the chemical energy of fluorine at low temperatures is abolished like that of other active substances, then some kind of glass or other transparent material not so brittle as calcium fluoride could be employed in the form of a tube, and its liquefaction achieved by the use of hydrogen as a cooling agent."

The inference that fluorine approached hydrogen in volatility was deduced by Wallach and Hensler from a consideration of the boiling points of the fluorine derivatives of the benzene series.

The following table :—

I.					
Benzene.	Boiling point.	Difference.	Toluene.	Boiling point.	Difference.
C_6H_6	80°	5°	$C_6H_5CH_3$	111°	5°
C_6H_5F	85°		$p-C_6H_4F \cdot CH_3$	116°	
C_6H_5Cl	132°	47°	$p-C_6H_4Cl \cdot CH_3$	160°	44°
Aniline.			Benzene.		
$C_6H_5NH_2$...	183°	4°	C_6H_6	80°	8°
$p-C_6H_4F \cdot NH_2$..	187°		$p-C_6H_4F_2$	88°	
$p-C_6H_4Cl \cdot NH_2$..	230°	43°	$p-C_6H_4Cl_2$	172°	84°

shows that the substitution of 1 atom of hydrogen in these compounds by fluorine only causes an increase of the boiling point of from 4° to 5° , whereas chlorine causes an increase of from 45° to 50° . Such a relatively large ratio as 1 to 10 in the increment of boiling points suggests a great difference in the volatility of the elements fluorine and chlorine in the free state. A further examination of the properties of fluorine compounds, however, showed that the volatility of fluorine was not likely to approach that of hydrogen. This will be apparent from the following table :—

II.

Methane.	Boiling point (absolute).	Difference.	Ethane.	Boiling point (absolute).	Difference.
CH ₄	110°	90°	C ₂ H ₆	184°	58°
CH ₃ Fl	200°		C ₂ H ₅ Fl...	242°	
CH ₃ Cl.....	250°	50°	C ₂ H ₅ Cl...	286°	44°
CH ₄	110°	149° = 4 × 37°	C·H ₄	110°	241° = 4 × 60°
CF ₄	259°		C·Cl ₄	351°	
Aldehyde.	B.p. (C.)		Benzaldehyde.	B.p. (C.)	
CH ₃ COH ...	21°	- 11°	C ₆ H ₅ COH	179°	- 18°
CH ₃ COFl ...	10°		C ₆ H ₅ COFl	161°	
CH ₃ COCl ...	51°	41°	C ₆ H ₅ COCl.	199°	38°

where it is seen that the substitution of hydrogen by fluorine in methane and ethane raises the boiling point by 90° and 60° respectively, and that the ratio of the increments of boiling point in corresponding fluorine and chlorine compounds is now not greater than 1 : 2. The boiling point of methyl fluoride was calculated from the critical point and vapour pressure of this substance as recorded by Professor Collie (*Trans.*, 1889, 55, 110). It will be noted as a curious fact that the substitution of fluorine in the aldehyde radicle causes a lowering of the boiling point and not an increase, and that the difference in boiling point between the chlorine and fluorine substitution body in either series is always between 40° and 50°. These considerations induced the hope that liquid air might give the command of a sufficiently low temperature for the liquefaction of fluorine, and that glass vessels might be used to collect the liquid. This view was supported by a consideration of the melting points of the halogens and the corresponding critical points deduced by following the suggestions of Clarke (*Am. Chem. Soc. J.*, 1896, 18, 618), as to these relations. Thus the absolute melting points of chlorine, bromine, and iodine are respectively 171°, 267°, and 388°, and, assuming the same mean difference in melting point extended to fluorine, then its melting point would be 64° absolute. Now the critical points of chlorine and bromine are about $2\frac{1}{3}$ times the absolute melting points, thus giving 149° absolute, or -125°, as the probable critical point of fluorine. This critical value is only a few degrees lower than oxygen, and from this calculation the authors were entitled to assume that the position of fluorine as regards volatility would be somewhere between that of oxygen and nitrogen.

The following research was conducted in the Chemical Laboratory of the Royal Institution, to which Professor Moissan brought the apparatus for the production of gaseous fluorine with which his name will always be identified, and the authors had the invaluable assistance of Messrs. Lebeau, Lennox, and Heath in the conduct of the experiments.

Fluorine was prepared by the electrolysis of potassium fluoride in solution in anhydrous hydrofluoric acid. The fluorine gas was freed from vapours of hydrofluoric acid by being passed through a serpentine of platinum cooled by a mixture of solid carbonic acid and alcohol. Two platinum tubes filled with perfectly dry sodium fluoride completed the purification.

The apparatus used for liquefying the gas consisted of a small cylinder of thin glass, to the upper part of which was fused a platinum tube. This latter contained in its axis another smaller tube, likewise of platinum. The gas to be liquefied enters by the annular space, passes through the glass envelope, and escapes through the small inner tube. The glass envelope was fused to the platinum tube by which the fluorine was supplied.

The glass cylinder being cooled down to the temperature of boiling liquid oxygen (-183°), the current of fluorine gas passed through the bulb without becoming liquid. At this low temperature, however, the gas has lost its chemical activity, and no longer attacks the glass.

On lowering the temperature of the liquid oxygen by exhaustion, a yellow liquid is seen collecting in the glass envelope, while gas no longer escapes from the apparatus. At this moment the tube by which the gas had been escaping is stopped, so as to prevent air from entering and liquefying, and the glass bulb soon becomes full of a clear yellow liquid, possessed of great mobility. The colour of this liquid is the same as that of fluorine gas when examined in a stratum one metre thick. Fluorine thus becomes liquid, according to this experiment, at about -185° .

When the bulb containing the liquid fluorine is lifted above the surface of the liquid oxygen, the yellow liquid begins to boil with an abundant disengagement of gas, having all the energetic reactions of fluorine.

Silicon, boron, carbon, sulphur, phosphorus, and reduced iron, cooled in liquid oxygen and then placed in an atmosphere of fluorine, did not become incandescent. At this low temperature, fluorine did not displace iodine from iodides. However, its chemical energy is still sufficiently great to decompose benzene or oil of turpentine with incandescence. It would thus seem that the powerful affinity of fluorine for hydrogen is the last to disappear. The authors have noticed on some occasions that a current of fluorine gas passed into liquid oxygen gives a flocculent precipitate of a white colour, which quickly settles

to the bottom. If this mixture is shaken and thrown on a filter, the substance can be collected. It possesses the curious property of deflagrating with violence as soon as the temperature rises.

A new apparatus (Fig. 1) was constructed similar to that already described (that is to say, a glass bulb, E, fused to a platinum tube, A, which contained another similar smaller tube, D) but having each of the platinum tubes, B and C, fitted with a screw valve, in such a manner that at any moment communication—either with the outer air or with the current of fluorine—could be interrupted. This little apparatus was placed in a cylindrical glass vacuum vessel containing liquid oxygen, connected with a vacuum pump and manometer.

On repeating the former experiment with freshly prepared liquid air, instead of oxygen, fluorine easily becomes liquid at -190° C. With liquid oxygen as refrigerant, the liquefaction of fluorine takes place at a temperature corresponding to the evaporation of the oxygen under a pressure of 437 mm. of mercury.

From these two experiments it results that the boiling point of fluorine is very close to -187° . This number is identical with Olszewski's boiling point of argon, so that this seems to be the first example of two gaseous elements boiling at the same temperature. It is a justifiable inference from the boiling point that the critical point must be about -120° , and thus, in all probability, the critical pressure is about 40 atmospheres, or less than half that of the critical pressure of chlorine, which is 84 atmospheres. This would make the critical constant for fluorine 4 as contrasted with chlorine, which has the value 5.

The following table gives the boiling points of the halogens :

	Absolute temperature.	Differ- ence.
Fluorine.....	86 ⁸⁶	154°.
Chlorine.....	240°	
Bromine.....	337°	97°
Iodine	460°	123°

When the little glass bulb was three-quarters full of liquid fluorine, both the valves were closed, and then a good air pump caused the liquid oxygen serving as refrigerant to boil rapidly at a pressure of 2.5 cm. Under these conditions, a temperature of -210° is reached, yet the fluorine did not show any sign of solidification, but retained its characteristic mobility. In future experiments it will be interesting to try the rapid ebullition of the liquid fluorine itself. During the

repetition of this experiment, a slight accident occurred. The screw of one of the valves becoming worn, allowed air to leak into the exhausted bulb. This air was immediately liquefied, and in a few moments two distinct layers of liquid were seen; the upper, colourless layer consisted of liquid air; the lower one, of a pale yellow colour, being fluorine.

To prevent the possible ingress of any air, the fluorine was introduced in its liquid state into a glass tube, the end of which was then sealed before the blow-pipe. The sealed tube, containing the liquid fluorine, was kept for a long time at -210° by the rapid evaporation of a large quantity of liquid air, but it gave no trace of a solid body.

To determine the density of liquid fluorine, it was brought into contact with a number of bodies whose density is known, comparing their behaviour at the same time in liquid oxygen, which has about the same boiling point and density. By taking groups of bodies whose densities are very close to each other, it is easy to see which sink and which float in the liquid. This well-known though indirect method was the most suitable for these delicate experiments. The authors first satisfied themselves that the fluorine had no action on the materials used. To effect this, a crystal of ammonium thiocyanate (density = 1.31) was placed in a glass tube surrounded with boiling liquid air to the bottom of the tube, a current of fluorine gas was introduced by means of a platinum jet. The fluorine was rapidly liquefied, and the ammonium thiocyanate was not attacked. The same experiment was repeated with a fragment of ebonite ($d = 1.15$), of caoutchouc ($d = 0.99$), of wood ($d = 0.96$), of amber ($d = 1.11$), and of methyl oxalate ($d = 1.15$). It is of importance, in the experiments just mentioned, that the various materials used should be first kept at a temperature of -190° for some little time before coming in contact with liquid fluorine.

In one of the experiments a piece of caoutchouc, having been insufficiently cooled, took fire on the surface of the liquid, and burnt completely away with a brilliant flame without leaving any residue of carbon. The piece of caoutchouc ran about the surface of the liquid like sodium on water, giving a very intense light.

The density experiment was carried out in the following manner:— In a glass tube closed at one end, and of which the lower part had been slightly drawn out, fragments of the five substances just mentioned were placed. The tube was then plunged to a third of its length into boiling liquid air. When it was all reduced to a temperature of about -190° the fluorine gas was carefully introduced. This soon liquefied, and the wood and the caoutchouc floated easily on the surface of the pale yellow liquid. On the other hand, the methyl oxalate and ebonite remained at the bottom, while the amber

rose and fell in the liquid, appearing to be of the same density. The apparatus was shaken several times, and the quantity of liquid fluorine increased, but the results were the same.

The authors thus arrive at the conclusion from these experiments that the density of liquid fluorine is about 1.14. Another point which appears to be of interest is the following. The fragment of amber floating in the fluorine was very difficult to distinguish, which would seem to indicate that the index of refraction of liquid fluorine is in any case greater than that of liquid air or oxygen, although it is not likely to be so high as that of amber itself.

Fluorine was liquefied in a thick-walled glass tube which had been previously graduated, and the tube sealed. On cooling the tube and its contents to -210° , a contraction of $\frac{1}{14}$ th in the volume of the liquid fluorine took place. A similar tube was left alone in a vacuum vessel full of liquid air. An hour and a half afterwards, the tube still being in liquid air, the fluorine had not changed in appearance. But shortly afterwards, when the air had all evaporated, a violent detonation occurred; the sealed tube and the double beaker in which it had been placed were smashed and reduced to powder.

Different samples of liquid fluorine examined with the spectroscope through a thickness of about $\frac{1}{2}$ cm. showed no specific absorption-bands in the visible spectrum.

Liquid fluorine placed between the poles of a powerful electromagnet does not show any magnetic phenomena. These experiments are the more decisive, as comparative ones with liquid oxygen were made at the same time.

The capillary constant of fluorine is smaller than that of liquid oxygen. A capillary tube, plunged successively in fluorine, oxygen, alcohol, and water, gave the following figures:

Height of liquid fluorine.....	3.5 mm.
„ „ oxygen	5.0 „
„ alcohol.....	14.0 „
„ water	22.0 „

Liquid fluorine placed in a glass tube surrounded with liquid air (temperature about -190° C.) had a slow current of hydrogen gas directed on to its surface by means of a fine platinum jet. There was immediate combustion with the production of flame. The experiment was repeated by dipping the platinum jet well below the surface of the liquid. At this temperature complete combination still took place, with a considerable evolution of light and heat.

Oil of turpentine, in the solid state, is attacked by liquid fluorine. To perform this experiment a little oil of turpentine was placed at the bottom of a glass tube surrounded with boiling liquid air. As soon as

a small quantity of fluorine was liquefied on the surface of the solid, combination took place with explosive force, a brilliant flash of light, and deposition of carbon. After each explosion, the current of fluorine gas was kept up slowly, a fresh quantity of liquid fluorine was formed, and the detonations succeeded each other at intervals of from 6—7 minutes. Finally, after a longer interval of about 9 minutes, the quantity of fluorine formed was sufficient to cause, at the moment of the reaction, the complete destruction of the apparatus. In several of these experiments a little liquid fluorine accidentally fell on the floor; the wood instantly took fire.

The action of liquid oxygen has been studied with more care, since the authors observed that by passing a current of fluorine through liquid oxygen, a detonating body could be produced.

If a current of fluorine is directed to the surface of liquid oxygen in a glass tube, the temperature being about -190° , the fluorine dissolves in all proportions, imparting a yellowish colour, and giving the liquid a graded tint from the upper to the lower part; the bottom of the tube is hardly coloured. If on the contrary, the fluorine gas is introduced at the bottom of the liquid oxygen, the yellow colour is produced at the bottom and diffuses slowly to the upper layers.

This phenomenon indicates that the densities of liquid fluorine and oxygen are very near each other. When the temperature of the mixture of liquid oxygen and fluorine is allowed to rise slowly, the oxygen evaporates first. The liquid becomes more and more concentrated as regards fluorine, and finally the latter begins to boil in its turn. In fact, at the commencement of this boiling the gas coming off will light a match which has only a red-hot point, and will not make lamp-black or silicon red-hot; but, on the other hand, the gas coming off at the end of the experiment will instantly cause these two latter bodies to burst into flame. When the glass bulb is completely empty and its temperature is rising, a distinct disengagement of heat is suddenly noticed, and the interior of the glass loses its polish. This rise in temperature is due to the fluorine gas attacking the glass. In this experiment, using perfectly dry oxygen, no precipitate is produced. If, on the contrary, oxygen is used which has been some hours in contact with the air, the detonating substance mentioned in previous experiments is produced.

The body which is produced by the action of fluorine on oxygen containing in suspension minute crystals of ice seems to be a hydrate of fluorine, decomposing, with detonation, by a simple rise of temperature. This view must, however, be taken as conjecture, until the real composition is ascertained. A small quantity of water at the bottom of a glass tube being cooled down to -190° , liquid fluorine formed on the surface of the ice as a mobile liquid without showing

any chemical action, and evaporated on the temperature rising. As soon as the apparatus became warmer the remaining gaseous fluorine attacked the ice with great energy, causing a strong smell of ozone.

A globule of mercury was treated in the same way as the water described above. The surface remaining very brilliant, the liquid fluorine surrounded it without causing any diminution of metallic lustre. On allowing the temperature to rise, the fluorine began to boil, and the liquid disappeared completely, without any attack of the mercury. The experiments seem to warrant the following conclusions.

Fluorine gas is easily liquefied at the temperature of boiling atmospheric air. The boiling point of liquid fluorine is -187° . It is soluble in all proportions in liquid oxygen and in liquid air. It does not solidify at -210° . Its density is 1.14, its capillarity is less than that of liquid oxygen; it has no absorption spectrum, and it is not magnetic.

Finally, at -190° it has no action on dry oxygen, water, or mercury, but it reacts, with incandescence, on hydrogen and oil of turpentine. Future experiments must decide whether cooling below -200° can suspend the powerful chemical action of liquid fluorine on hydrogen and hydrocarbons.

One of the most important questions for future investigation is the specific refractive and dispersive indices of the fluid. Davy, in his paper on the substances produced in different chemical processes on fluor-spar (*Phil. Trans.*, 1813, 278), says, "Dr. Wollaston has found that the fluoric combinations have very low powers of refracting light, and particularly the pure fluoric acid; so that the refracting powers of fluorine will probably be found lower than those of any other substance, and it appears to possess higher acidifying and saturating powers than either oxygen or chlorine."

Gladstone has shown that the specific atomic refraction of the combined element does not exceed 0.9, taking the Lorentz formula, and that the atomic dispersion diminishes instead of increasing for short wave-lengths. Further, he found that the other halogen substitution compounds gave atomic refractions nearly agreeing with the same substances in the free state. It has been found that liquid gases give the same atomic refraction as the gaseous body, so that the refractive index of liquid fluorine may be at once deduced provided it behaves like chlorine, bromine, or iodine. Taking 0.9 as the atomic refraction, the value would be, according to the Gladstone formula, 1.054, and the Lorentz, 1.081. Both values are far lower than those of liquid oxygen or air, 1.226 and 1.205 respectively. The general appearance of the liquid and the experiment with amber described above lead to the conclusion that liquid fluorine must have a refractive index much higher than that calculated. If the

refractive index is as great as 1.41, then the atomic refraction (Lorentz) will be 4.13, but if it is only about 1.192, then the atomic refraction will be 2. On both assumptions the atomic refraction of liquid fluorine is much greater than the value 0.9 found by Gladstone. Should the smaller value 2 turn out to be the correct one then the inference might be fairly drawn that the critical constant was also about 3, or nearly the value for oxygen. This view would make the critical pressure of fluorine about the same as that of oxygen, or 50 atmospheres. From this it would follow that, unlike chlorine, bromine, and iodine, which have the same atomic refraction in combination and in the free state, fluorine has a different value in the one state as compared to the other. In this respect it would appear to resemble oxygen, whose atomic refraction in combination may be only three-fourths of what it is in the free state. This view is confirmed by an examination of the atomic volume of fluorine. The other members of the halogen series have approximately the same atomic volume in combination as in the free state. Now, the atomic volume of fluorine in fluorbenzene is 11.5, or about half the atomic volume of chlorine, or taking chlorobenzene as standard, with chlorine as 22.7, then the atomic volume would be 10. The value for the free element appears to be 16.6, and the number deduced from liquid hydrofluoric acid about 15. Many metallic fluorides have relatively small atomic volumes. Thus the fluorides of cadmium, lithium, calcium, magnesium, and aluminium have an atomic volume just about half of that of the corresponding chloride. This difference is, however, easily explained if fluorine in the combined state has only half the atomic volume of chlorine. Dr. Thorpe's value for the atomic volume of fluorine, deduced from a study of the chloride and fluoride of arsenic, is 9.2, or free fluorine at its boiling point ought to have a density of 2, provided it behaved like the other halogens. This density for the free element is much too high, the experimental value being about 1.14. Such changes in atomic volume again suggest a resemblance with oxygen, and would lead to the inference that the refractive constants must also differ in the free and combined states. These interesting problems must, however, be left for future investigation.

DISCUSSION.

Dr. PERKIN said he felt much interested in the paper, because of the remarkable magnetic rotation of combined fluorine, for example, in fluorbenzene. When one atom of hydrogen in benzene is displaced by chlorine, the rotation is considerably increased. The substitution of bromine causes a still higher rotation, and that of iodine the highest. On the other hand, the substitution of fluorine reduces the

magnetic rotation. He had suggested that this might be accounted for if fluorine were paramagnetic, because its magnetic rotation would then be the reverse of that of carbon and hydrogen. This, however, does not seem to be a probable explanation, since it is now found that liquid fluorine is not paramagnetic. It is possible that this element may have different values depending on whether it is free or combined. The nitro-group (NO_2) influences magnetic rotation much in the same way as fluorine.

Dr. GLADSTONE remarked on the importance of Professor Dewar's communication, the most interesting portion to him being that on the optical properties of the liquid fluorine. The specific refraction of that element had been calculated by him and his brother from fluorbenzene and from many salts, crystallised or in solution, with the invariable result that it was exceedingly small. In the last list of the specific refractions of the elements (*Proc. R. S.*, 1897, 60, 141) it is given at only 0.031, which is not a third of the next lowest in the list. Its specific dispersion is also low, and it has the additional peculiarity of giving a reversed spectrum. Now Prof. Dewar finds that liquid fluorine has about the same refractive index as that of amber; this is known to be 1.55 or thereabouts. As the specific gravity of the fluorine is stated to have been 1.14, we can easily calculate the specific refraction, viz., 0.482. This figure, instead of being the lowest in the list of elements, is nearly the highest, there being only six with higher values.

It is true that in some cases the specific refraction of an element in the free state differs somewhat from that deduced from its compounds. Fluorine would naturally be compared with the three halogens, chlorine, bromine, and iodine. Liquid chlorine has a specific refraction of about 0.27; in combination 0.28. Bromine has a specific refraction of about 0.20; in combination 0.21. Iodine vapour has a specific refraction of about 0.19; in combination 0.21. The free element, therefore, does not differ widely in specific refraction from the same element when in combination; and in each case is the smaller and not the greater of the two. A certain analogy does exist between fluorine and sulphur or phosphorus. These two when melted have high specific refractions, sulphur being 0.50, and phosphorus 0.59; these high figures are generally much reduced when the elements are in combination, but the extent of this reduction is by no means comparable with what would appear to be the case with fluorine. Although Professor Dewar's method is correct in principle, Dr. Gladstone expressed a strong hope that accurate determinations would be made by one or other of the more direct methods.

Dr. THORPE said, in reference to the allusion by the President to his determination of the specific molecular volume of fluorine as far back

as 1880, that too much stress could not be laid upon the particular value viz., 9.2, which he then obtained. It was deduced from a study of the specific gravity and thermal expansion of arsenic fluoride, a substance which is not easy to obtain pure, and which is not altogether without action on glass, especially at temperatures approaching the boiling point. It, moreover, presupposes that arsenic fluoride has a molecular constituent analogous to that of arsenic chloride. Such an assumption is probable, but having regard to the remarkable complexity of many fluorine compounds, as, for example, hydrogen fluoride itself, when compared with the corresponding chlorine compounds, the supposition cannot, at present, be regarded as more than probable. The particular value obtained, however, clearly indicated the order of the magnitude, as shown by its substantial agreement with the other values quoted by the author.

With respect to the question raised by Dr. Gladstone, he might say that the peculiar behaviour of glass when immersed in arsenic fluoride was significant, and suggested a method by which the refractivity of liquid fluorine in the free state might be ascertained with a fair approximation to accuracy, viz., on the same principle as that adopted by the authors in determining the relative density of liquid fluorine—that is, by immersing solids of known refractivity in the liquid, and observing which became invisible. Arsenic fluoride is a highly refractive liquid, and some specimens of glass threads and tubes become almost invisible when immersed in it.

Professor DEWAR, in reply, observed that he did not intend to convey the impression that, because amber in liquid fluorine might be difficult to define clearly, it necessarily followed that the refractive index would turn out to reach 1.55, as Dr. Gladstone seemed to infer. His present impression was that it exceeded that of liquid air, but he could go no further. No doubt the next time Professor Moissan and he had the opportunity of continuing the experiment, a direct determination of the refractive index would be made.

***112. "The liquefaction of air and the detection of impurities."
By Professor Dewar.**

In a paper on "The relative behaviour of chemically prepared, and of atmospheric nitrogen," read before the Society in the year 1894, it was stated that all samples of nitrogen and oxygen properly purified, are, when liquefied, clear transparent liquids, so that the solid matter which always separates when air or nitrogen or oxygen is liquefied on the large scale consists of impurities. Ordinary air, containing 4 parts of carbonic acid per 10,000 parts gave a turbid liquid from the solidification of the carbonic acid; and oxygen containing traces of

APPARATUS FOR LIQUEFACTION OF FLUORINE.

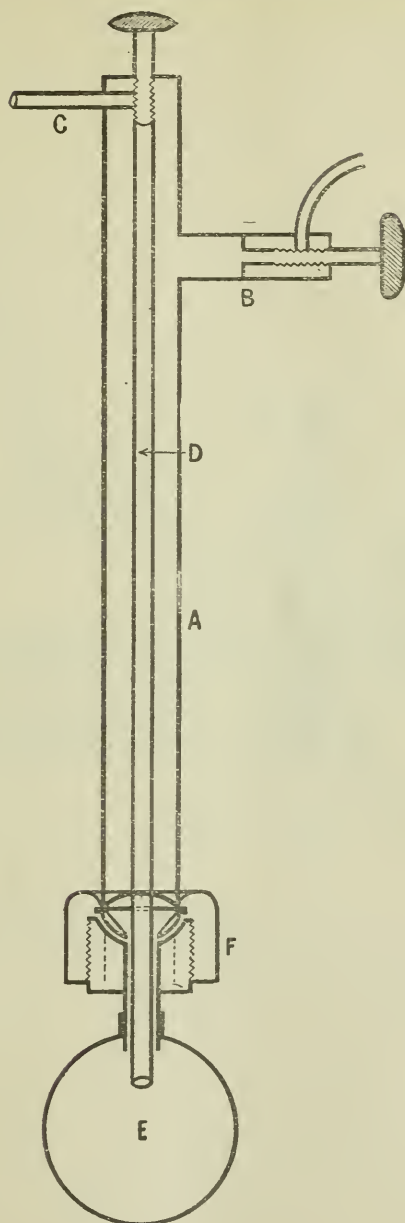


FIG. 1.

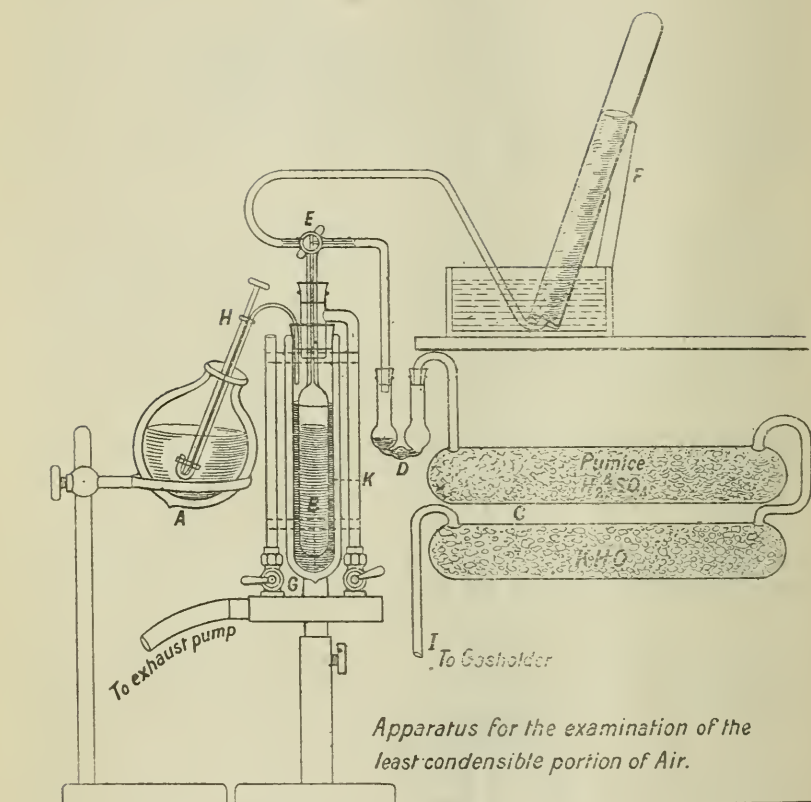


FIG. 2.

chlorine behaved in a similar manner. With the object of ascertaining the proportion of any gas in air that is not condensable at about -210° C. under atmospheric pressure, or is not soluble in liquid air under the same conditions, the following apparatus has been devised. A cylindrical bulb of a capacity of 101 c.c., marked B in figure, had a capillary tube sealed into it terminating in a three-way stopcock, as shown at E. The parts marked C and D consist of soda-lime and sulphuric acid tubes for removing carbonic acid and water. The stand marked G holds the large vacuum test tube into which B is inserted which holds the liquid air maintained under continuous exhaustion. As this low temperature had to be kept steady for from one to two hours, while at the same time the bulb B had to be completely covered with liquid air, it was necessary to arrange some means of keeping up the liquid air supply without disturbing the apparatus. The plan adopted is shown at H, which is a valve arrangement which can be so regulated as to suck liquid air from the large vacuum vessel A and discharge it continuously along a pipe into the vacuum test tube G, the latter being kept under good exhaustion. In working the apparatus, the tube I is connected to a gasometer containing 10 cubic feet of air, so that the volume of air condensed in each experiment may be observed. This was generally from $2\frac{1}{2}$ to 3 cubic feet. If there is a very small proportion of some substance not liquefiable or soluble in liquid air, then we should expect the vessel B would not fill up completely into the capillary tube. This is, however, exactly what does take place. After 40 minutes' cooling, the vessel B and the cool part of the tube were filled with liquid. In this experiment some 80 litres of air were condensed, and any accumulated uncondensed matter must have been concentrated in the upper part of the capillary tube which had a volume of 0.5 c.c. Under the conditions, therefore, the material looked for must be less than 1 part by volume in 180,000 of air.

To test the working with an uncondensable gas added to air, a volume of 10 cubic feet was taken in the gasholder and to that 500 c.c. of hydrogen were added. This is in the proportion of less than 1 in 500. Even after two hours' cooling, the tube B could only be filled four-fifths. In order to prove that the gas accumulated in the upper part of B was hydrogen, the three-way stopcock at E was turned, and the temperature allowed to rise so that the gas was expelled from the evaporation of the liquid air and collected over mercury as shown at F. The gas thus collected was easily combustible and consisted chiefly of hydrogen. The amount of hydrogen was then reduced to 1 part in 1,000 of air, and it was found that after one and a quarter hour's cooling the bulb B had filled to within a half c.c. of the capillary tube. A new sample of air containing 1 part of hydro-

gen in 10,000 of air filled the bulb B completely as if it were ordinary air.

It appears from these experiments that 1 part of hydrogen in 1,000 of air is just detectable by this plan of working. As the 80 litres of air condensed contained some 80 c.c. of hydrogen, it appears that 100 c.c. of liquid air at from -200° to -210° C. had dissolved nearly all this gas; in fact, that 20 c.c. of hydrogen at the low temperature is dissolved in 100 c.c. of liquid air. In the paper on "The liquefaction of air and research at low temperatures" (Proc., 1895, 11, 221), it was shown that if hydrogen containing a small percentage of oxygen were employed for the purpose of getting a hydrogen jet, the liquid collected from it was oxygen, containing, however, so much hydrogen dissolved in it that the gas coming off for a time was explosive.

In order to press this inquiry a little further, some natural gas known to contain a different constituent like helium suggested itself as being worthy of trial. Lord Rayleigh's results of the examination of the gas from the King's Well at Bath showed that it contained 1.2 part of helium per 1,000 volumes, so that it seemed admirably adapted for such experiments. The author has to express his thanks to the Corporation of Bath for giving permission to collect samples of the gas.

The sample of gas from the Bath Spring was treated exactly in the same way as the hydrogen mixtures described above. During the liquefaction there was a marked difference in the appearance of the liquefied gas, for while the hydrogen and air mixtures gave a clear, transparent liquid, the product from the Bath gas was turbid, and the precipitate by transmitted light looked yellow-brown. This solid turns out to be of organic origin, probably of the petroleum order of compounds. It has a very marked aromatic smell resembling such bodies. The trace of material left, gave, after treatment with concentrated nitric acid, the smell of nitrobenzene; and as its detection cannot be explained by the presence of any material of the kind in the vessels used in collecting, it must be assumed to be a normal constituent of the Bath gas. A further quantity of the Bath gas must be collected in order to confirm the presence of such bodies and to definitely make out their nature. Another peculiarity of the liquid is that, on examining it with the spectroscope, even through a thickness of 2 inches, no trace of the characteristic oxygen absorption spectrum could be detected. In all attempts to make nitrogen for liquefaction on the large scale, oxygen could always be detected in the liquid with the greatest ease by means of its absorption spectrum. After the cooling had continued for 1 hour the gas ceased to flow into the condensing vessel, and some 20 c.c. at the upper part of the glass cylinder B was filled with a gas that had not undergone liquefaction or solution. About 70 litres of the Bath gas were condensed, certainly the largest

quantity of this gas ever subjected to chemical examination. This was boiled off just as the hydrogen was treated in the experiments described above, and as, by accident, too much nitrogen had volatilised along with the gas, oxygen was added and the mixture sparked over alkali to get rid of the excess of nitrogen. During the sparking, the helium lines were well marked (along with others the origin of which must be settled later), and a vacuum tube filled with the product of the sparking gave a splendid spectrum of the gas. The sample of gas directly collected from the liquid nitrogen contained about 50 per cent. of helium. It is therefore possible to separate helium from a gas when it is only present to the extent of one-thousandth part by liquefaction in the manner described. From this it would appear that helium is less soluble in liquid nitrogen than hydrogen is in liquid air, and is of greater volatility than either of the constituents of air, as Professor Olszewski found (*Bull. Ac. Crac.*, 1896, 297) by direct experiment on a pure sample of the gas sent to Cracow by Professor Ramsay with the object of liquefaction. In the author's lecture (*Proc. Roy. Inst.*, 1896), entitled "New researches on liquid air," the following observation occurs: "The exceptionally small refractive value observed by Lord Rayleigh in the case of helium shows that the critical pressure of this body is proportionately high. It would therefore be more difficult to liquefy than a substance having about the same critical temperature but possessing a lower critical pressure than hydrogen." Now that it has been shown by Professor Moissan and the author that two substances like fluorine and argon, differing by 2 units in molecular weight, boil at nearly the same temperature, it seems reasonable to extend the analogy to the case of hydrogen and helium where the same difference occurs, and to suggest that they also probably have about the same volatility. If the sample of uncondensed gas resulting from the first liquefaction of the Bath gas were again treated in the same way, a much more concentrated specimen of helium could be obtained. Provided helium were wanted on a large scale, then a liquid air apparatus similar to that in use at the Royal Institution transported to Bath and worked with the gas from the King's Well could be made to yield a good supply. With a modified form of apparatus, it will be possible to collect any residuary gas from the use, not of 3 cubic feet of air or Bath gas, but from hundreds of cubic feet of such products. This investigation will be continued with new samples, in order to see if the composition of the gases changes and to isolate the hydrocarbons.

The author has to thank Mr. Lennox and Mr. Heath for able assistance in carrying out the experiments.

DISCUSSION.

Sir WILLIAM CROOKES said that a few days ago he received from Professor Dewar a tube containing some of the gas at atmospheric pressure. A small quantity was let into a new and completely exhausted spectrum tube, which was then re-exhausted and filled several times. On exhausting to 5 mm. pressure and passing an induction spark it showed the nitrogen spectrum brilliantly, and on intercalating a condenser the yellow helium line was visible, but too faint to be measurable in the large spectrocope. To remove the nitrogen, 47 c.c. were mixed in an eudiometer with an equal volume of oxygen, and sparked for about 8 hours, absorption of the products being effected by strong potash solution over the mercury. When contraction had ceased, the residual oxygen was absorbed by passing pyrogallol into the potash. The unabsorbed gas amounted to 25 c.c. This gas, dried over phosphoric anhydride, was examined in a new spectrum tube, end on. (Tube shown in action.) It gave the helium line (wave-length 5875·87) brilliantly, together with the other helium lines. No argon lines could be seen.

***113. "The absorption of hydrogen by palladium at high temperatures and pressures." By Professor Dewar.**

One of the author's earliest papers was entitled "The motion of a palladium plate during the formation of Graham's hydrogenium." The explanation of the motion together with a record of other experiments can be found in the *Proc. Roy. Soc. Edin.*, 1868, 6, 504.

A subsequent investigation by the author into the physical constants of hydrogenium appeared in the *Trans. Roy. Soc. Edin.*, 1876, 27, 167, and had reference to the specific gravity, specific heat, and coefficient of expansion of the occluded hydrogen. These observations led to the conclusion that the specific gravity was independent of the amount of condensed gas, and had a mean value of 0·62. The specific heat, relatively to palladium, of the condensed hydrogen appeared to vary inversely as the quantity occluded, but taken relatively to successive charges was nearly constant, having the value 3·4, which is identical with that of gaseous hydrogen at constant pressure. The coefficient of cubical expansion of the alloy is about twice that of palladium, and that of the hydrogen in its compressed state not more than three times that of mercury. A later communication was made to the Philosophical Society of Cambridge (*Proc.*, 1878, 3, 207) dealing with the thermo electric relations and electric conductivity of hydrogenium. It was shown that the potential difference of a junction of hydrogenium-

palladium is at ordinary temperature nearly equal to that of an iron-copper junction, and that it increases with the temperature according to the general parabolic law; the rate of the increase being, however, greater than iron-copper and subject to a regular variation on account of successive heatings. The formation of thermo-electric piles, and of neutral points in a wire of this substance, along with the continuous formation of thermo-electric currents through the application of a hydrogen flame were explained. Experiments on electric resistance proved that it increases directly with the amount of hydrogen condensed in the palladium.

Subsequent investigators have dealt more elaborately with the many problems suggested by hydrogenised palladium, but so far the essential facts referred to above have been confirmed.

In the course of the early observations the following experiment is recorded as illustrating the absorption of hydrogen by palladium at a red heat.

Take a strip of thin sheet palladium, 4 or 5 cm. long, and about 5 mm. in breadth, clamp it firmly by the end in a suitable support, so that the strip is free to vibrate, and insert it edgewise in the middle of a hydrogen flame, burning from a nozzle about 1 mm. in diameter. If the palladium be now depressed into the inner dark cone it immediately begins to vibrate, producing a low, musical note.

If the flame be extinguished by stopping the current of hydrogen for an instant, on allowing the gas to flow, the vibration commences again, and may be kept up without any actual flame.

The motion in this position in the flame is due to the absorption of hydrogen on the cool side next the inner cone, with its attendant increase of length, producing a bending of the sheet into the hot portion of the flame, where the hydrogen is instantly expelled from the palladium, which is forced to return to its original position from its natural elasticity.

It is now known that no absorption of hydrogen at atmospheric pressure by palladium takes place above 145°C. , so that the cause of motion must originate at a comparatively low temperature. The question arises, Can palladium, under any condition of pressure, absorb hydrogen at a red heat in quantity at all comparable to what it can do at lower temperatures? If free hydrogen and palladium-hydrogen are compared as regards volatility, the one boils at 30° (abs.), the other at 420° (abs.), very much like two isomeric forms of the same substance. This ratio of 1:14 given (and certainly the ratio could not be made greater than 1:16, since the absolute boiling points may be taken as in the ratio of their respective critical points) we thus arrive at a hypothetical palladium-hydrogen critical point of 640° (abs.) or 366°C. An almost exact parallel may be drawn between

palladium-hydrogen in its relation to free hydrogen and iridium oxide in its relation to free oxygen. Thus liquid oxygen boils at 90° (abs.) and the tension of dissociation of iridium oxide is 1 atmosphere at 1423° (abs.). The ratio of the absolute boiling points of liquid oxygen and the oxygen of iridium oxide are therefore as 1 : 15.9, which is almost the same value as that found above for the relative volatilities of hydrogen and palladium. In either case, the ratio of the absolute boiling points of the respective substances may be taken as approximately representing the ratio of the latent heats of transition of state. It might then be possible that palladium no longer absorbed hydrogen under any condition of pressure. The present experiments were undertaken with the view of answering this question.

The diagram (3) shows the general arrangement of the apparatus most suitable for examining the behaviour of the metals like palladium, sodium, potassium, &c., towards hydrogen at high temperatures and pressures.

A rod of palladium A weighing about 119 gms., kindly placed at my disposal by Mr. George Matthey, F.R.S., was placed in a strong steel cylinder D having an accurately fitting conical joint. As little extra space as possible was left in the cylinder, which was heated in a bath of fusible metal E. The vessel was connected with the manometer B by a strong copper tube, and the latter was similarly joined to a compressed gas cylinder H containing hydrogen. The apparatus, without the palladium, must be carefully tested at high pressures and temperatures. There must be no trace of a leak. An extra stop-cock at C enabled the hydrogen accumulated in the apparatus to be blown off suddenly when required, after the hydrogen cylinder stop-cock was shut off. Before commencing the experiments at high temperatures, it is well to charge the apparatus to a pressure of 20 atmospheres with hydrogen and then blow off the gas and measure it. In this way the volume of hydrogen that is absorbed for every diminution of the pressure of hydrogen is known. In the first experiments a pressure of 20 atmospheres of hydrogen in the apparatus corresponded to 780 c.c. of gas, measured at atmospheric pressure. When the fusible metal bath was heated to 420° and hydrogen at a pressure of 80 atmospheres introduced at starting, it fell to a pressure of 60 atmospheres in $2\frac{1}{2}$ minutes. Blowing off the gas instantly to get rid of accumulated impurities and again applying a pressure of 80 atmospheres of hydrogen, the pressure was reduced to 60 atmospheres in 6 minutes. When the same operations were repeated a third time, the diminution of pressure by 20 atmospheres took 16 minutes, and a fourth operation required 28 minutes. In all, therefore, upwards of 3,000 c.c. of hydrogen were absorbed in less than an hour. If the palladium could

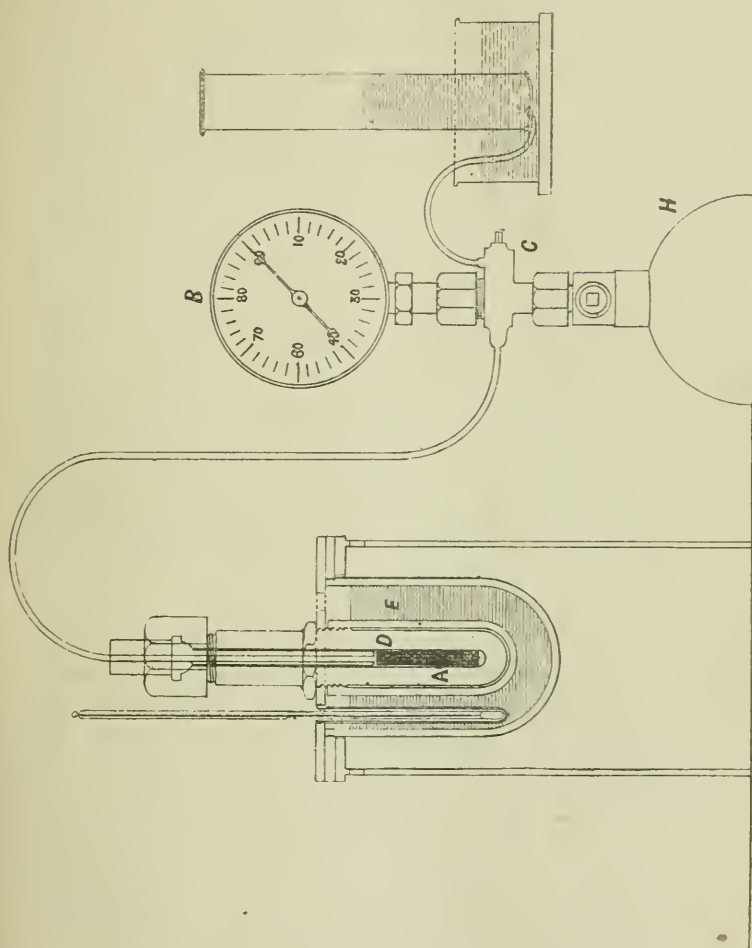


FIG. 3.

be seen at about a low red heat, then during the rapid absorption of the hydrogen as described in the last experiment, the temperature must rise very considerably, and the metal, during the operation, must actually appear to grow much brighter. Calculating from the tensions of the gas, the evolution of heat at 300° must be about 4698 gram-units of heat per gram of hydrogen absorbed. The reverse action would take place on reducing the pressure of hydrogen in the charged palladium. After the four charges the pressure remained constant at 80 atmospheres, no more hydrogen being absorbed. The hydrogen gas outside the palladium was now suddenly blown off, the stopcock shut, and the pressure allowed to rise from the escape of gas absorbed by the palladium. In this way it was noted that a pressure of 40 atmospheres was reached in half an hour. The whole amount of gas that had been absorbed by the metal was found, on measurement, to be 2,980 c.c. After the first charge of hydrogen the steel cylinder was opened and the palladium examined. It was found to have a deep rent in it extending along nearly the whole length of the rod. During the occlusion of the hydrogen the volume of the metal is increased by one-tenth, so that in the passage of hydrogen in and out of the metal enormous strains must be produced. As the volume of the original metal is a little less than 10 c.c., it may be taken that above 300 times its volume of hydrogen had been absorbed at the temperature of 420° and under a pressure of 80 atmospheres. The free space in the manometer and connections was now diminished, so that a pressure of 20 atmospheres corresponded to a volume of 300 c.c. of hydrogen instead of 780 c.c. as above. The palladium was saturated at 360° C. under a pressure of 80 atmospheres in the manner described above, except that a very much larger number of charges of hydrogen had to be employed. After saturation, the pressure of hydrogen was slowly reduced to 25 atmospheres: it rose to 30 atmospheres from gas passing outwards from the metal, now heated up to 500° C., and finally reached 100 atmospheres; on cooling to 400° the pressure diminished from reabsorption of the hydrogen. On blowing off the gas between 400° C. and 500° C. 1,400 c.c. of free and 3,300 c.c. of combined hydrogen were found. A rod of palladium, in this way, can be quickly charged with hydrogen at about 300° C. or 400° C., and as it is only the pure gas that is occluded, this process may be used as a rapid means of getting pure hydrogen in quantity for experimental purposes.

In the next experiment, the palladium was heated to 500° C. before any hydrogen under pressure was applied. No absorption was observed till the pressure of hydrogen reached 60 atmospheres. On charging as before at pressures between 80 atmospheres and 60 atmospheres, the metal was found to absorb 1,900 c.c. of gas. The experiment was repeated, with the difference that the charging pressure of hydrogen

was raised to between 120 atmospheres and 100 atmospheres, and it was found that the palladium had now occluded 3,700 c.c. of hydrogen. Thus it appears from these experiments that at 500° C. palladium can still occlude 300 times its volume of hydrogen under a pressure of 120 atmospheres. The observations on the tension of hydrogen in palladium by Troost and Hautefeuille showed that, for the same temperature, the values became constant and independent of the amount of occluded gas, only when the volume of hydrogen absorbed lay between 200 and 600 times that of the metal. Any other proportions gave variable tensions for the same temperature. The fact that 300 volumes can still be occluded at 500° C. seems to show that palladium and hydrogen, under such conditions, still follow the same laws of absorption as at lower temperatures. Nothing analogous to a critical point, where no combination takes place between the metal and hydrogen, has been reached.

Hoitsema published an important paper on palladium-hydrogen tensions in the *Archives Néerlandaises*, 1896, 30, 44. In this memoir, Hoitsema gives also a series of observations on the same subject made by Roozeboom. Taking the tensions given by the latter (simply because the curve seems more regular) for the horizontal portions of the dissociation curves at different temperatures, and calculating a Willard Gibbs' formula, from the following data, viz., 20° C. pressure 7 mm. ; 100° C. pressure 205 mm. ; 170° C. pressure 1467 mm., the expression results (where T is the absolute temperature)

$$\log. p = 7.00338 - \frac{1983.4}{T} + 0.2378 \log. T.$$

From this it follows that the latent heat of dissociation of the palladium-hydrogen per atom of hydrogen in gram-units is $4561 + 0.2378 T$. This would seem to show the latent heat of dissociation increases instead of diminishing with temperature. In other words, the heat of combination should be rather greater at higher temperatures, instead of diminishing as it must do if a point where no occlusion takes place were being approached. Thus theory and experiment would seem to agree.

The best and safest method for the experimental study of the relations of hydrogen and palladium at high temperatures and pressures would be to investigate the change of electrical resistance in a heated wire of the metal when subjected to different hydrogen pressures. The problem is, no doubt, more complicated, still interesting results must follow from such an investigation. Some of the electrical properties of hydrogen and palladium at low temperatures have been determined by Professor Fleming and the author, and the results will appear in future publications bearing on the subject.

The author is indebted to Mr. Robert Lennox for able assistance in the conduct of the experiments.

DISCUSSION.

Mr. R. J. FRISWELL asked whether the President had made any measurements of the tensile strength of the steel. He was astonished to hear of the metal standing 100 atmospheres at over 500° C. He was asking for information, as he had been unable to obtain any data as to the strength of metals near a red heat, a point at which it must be rapidly falling away. The matter was of great interest for experimenters using autoclaves. Engineers did not seem to have done any work on tensile strength at points above the temperatures usual in steam boilers.

Prof. DEWAR, in reply to Mr. Friswell, agreed that no engineering formulæ existed. The experiments were dangerous, but one had to take the risk. The metal used was Whitworth compressed steel, and the vessel was made by drilling out a solid mass. He had no data as to tensile strength, the results were desired and the risk taken.

114. "On some yellow vegetable colouring matters." By A. G. Perkin.

The *Rhus rhodanthema*, a tree growing to the height of 70 or 80 feet, is indigenous to northern New South Wales. The colouring matter $C_{15}H_{10}O_6$ is identical with fisetin. A glucoside of fisetin, $C_{36}H_{30}O_{16}$ ($C=60.18$; $H=4.45$), colourless needles, m. p. 215—217°, is also present; it is decomposed with difficulty by boiling dilute acids. This closely resembles fustin, $C_{58}H_{46}O_{23}$ or $C_{36}H_{26}O_{14}$ ($C=63.34$; $H=3.81$), m. p. 217—219°, the fisetin glucoside of *R. Cotinus* (Schmid, *Ber.*, 1886, 19, 1753), but differs from it in percentage composition. Its decomposition with acid would be closely expressed by the equation $C_{36}H_{30}O_{16} + 2H_2O = 2C_{15}H_{10}O_6 + C_6H_{14}O_6$, if rhamnose or glucose are liberated by this reaction. Gallic acid was also isolated, evidently as a decomposition product of gallotannic acid contained in the wood.

Berberis ortuensis, a plant resembling *Berberis vulgaris*, flourishes in Cyprus. It was found to contain berberine, but no colouring matter of the mordant yellow class.

The perianths surrounding the seeds of *Rumex obtusifolius* contain a trace of quercetin, which is interesting, as in many roots of this species methylanthraquinone derivatives also exist. It is also pointed out that the leaves and green stems of madder (*Rubia tinctoria*) contain a yellow colouring matter which will be examined.

115. "Naphthylureas." By George Young, Ph.D., and Ernest Clark.

The mononaphthylureas may be prepared by the action of potassium cyanate on the hydrochloride of the corresponding naphthylamine. In consequence of the rapid conversion of the mononaphthylureas into the symmetrical di-naphthylureas which takes place on heating, even below the melting points of the former, the true melting points have escaped the observation of previous authors. α -Naphthylurea melts at $213-214^{\circ}$, at which temperature it is converted into di- α -naphthylurea, melting at $284-286^{\circ}$. β -Naphthylurea melts at $213-215^{\circ}$, and immediately forms di- β -naphthylurea, melting at $289-290^{\circ}$. Acetyl- α -naphthylurea, m. p. $214-215^{\circ}$; benzoyl- α -naphthylurea, m. p. $243-243.5^{\circ}$; acetyl- β -naphthylurea, m. p. $202-203.5^{\circ}$; benzoyl- β -naphthylurea, m. p. $219-220^{\circ}$.

116 "Benzoylphenylsemicarbazide." Preliminary notice. By George Young, Ph.D., and Henry Annable.

In a previous communication presented to the Society (Trans., 1897, 71, 200), attention was drawn to the disagreement between the melting points of benzoylphenylsemicarbazide, $202-203^{\circ}$, as observed by Michaelis and Schmidt (*Ber.*, 1887, 20, 1713), and $210-211^{\circ}$ as observed by Widman (*Ber.*, 1893, 26, 945). It described the preparation and examination of this substance—melting at $202-203^{\circ}$ —and suggested the possible existence of two benzoylphenylsemicarbazides both having the constitutional formula, $C_6H_5N(COC_6H_5) \cdot NH \cdot CO \cdot NH_2$. Shortly after the publication of this paper, Dr. Widman had the courtesy to submit a sample of his preparation for comparison. This sample had been observed by Dr. Widman to melt at $210-212^{\circ}$; the authors found it to melt at $211-212^{\circ}$. Their thermometer agreed therefore with Dr. Widman's. A comparison of the properties of the two preparations led to exceedingly interesting results. Widman's benzoylphenylsemicarbazide seemed to be almost, if not quite, insoluble in boiling benzene, the melting point remaining unaffected. The authors' benzoylphenylsemicarbazide was fairly soluble in boiling benzene, crystallising out again on cooling. Mere recrystallisation from benzene did not affect the substance, but prolonged boiling with benzene caused a gradual rise of the melting point. On the other hand, the substance was easily soluble in boiling water and crystallised out on cooling unchanged, whereas Dr. Widman's preparation dissolved in boiling water with difficulty and crystallised out on cooling, with the melting point considerably lowered. These results induced the authors to undertake a thorough investigation of the formation and properties of benzoylphenylsemicarbazide. They have

been able to determine that the action of benzoyl chloride on phenylsemicarbazide produces under different conditions three distinct forms of benzoylphenylsemicarbazide. These three forms melt respectively at $202-203^{\circ}$, $205-206^{\circ}$ and $210-211^{\circ}$. They are each capable of conversion into either of the other two. They exhibit different and characteristic crystalline structures under the microscope. They possess different solubilities and densities. The form of highest melting point seems incapable of solution without undergoing at least partial change into one or other of the lower melting forms, but pure solutions of these latter may be easily prepared. These solutions have no action on polarised light. The authors are at present engaged in examining the physical properties of these substances and in extending the investigation to a number of other closely related compounds, in the hope of being able to determine whether they are capable of existence in two or more modifications.

117. "Sulphocamphylic acid." By W. H. Perkin, jun.

In a previous communication (Proc., 1895, 11, 23) it was shown that when the potassium salt of sulphocamphylic acid is treated with phosphorus pentabromide, the sulphobromide, $C_8H_{12}(SO_2Br) \cdot CO_2H$, is produced, and from this substance by elimination of sulphur dioxide an acid of the formula $C_8H_{12}Br \cdot CO_2H$ was obtained, which, as it gives β -camphylic acid, $C_8H_{11}CO_2H$, on treatment with alcoholic potash, may be called *bromodihydro- β -camphylic acid*.

During the course of further experiments, the corresponding *camphylic sulphochloride*, $C_8H_{12}(SO_2Cl)CO_2H$, has been obtained by treating the potassium salt of sulphocamphylic acid at 0° with phosphorus pentachloride. This substance melts at $168-170^{\circ}$, and at the same time slowly undergoes decomposition with evolution of sulphur dioxide and formation of *chlordihydro- β -camphylic acid*, a crystalline substance which melts at $105-106^{\circ}$.

Like the corresponding bromo-compound, it is decomposed by boiling with alcoholic potash, with elimination of hydrogen chloride and formation of β -camphylic acid.

In the last communication on sulphocamphylic acid (Proc., 1896, 12, 189) it was stated that, when β -camphylic acid was treated with phosphorus trichloride, and the product distilled under reduced pressure, the chloride of an acid melting at 130° is obtained which was called *iso- β -camphylic acid*, because at the time it was thought that this acid might prove to be isomeric with β -camphylic acid. It has since been found that the reaction does not proceed in this way, but that the following much more remarkable change takes place. When the chloride of β -camphylic acid is distilled, there is, as already men-

tioned, some decomposition and charring, and during this distillation the chloride is *reduced* almost completely to the chloride of an acid, $C_9H_{14}O_2$, which on investigation has been found to be identical with isolaunonic acid, the acid which Koenigs and Hoerlin (*Ber.*, 1893, 26, 813), and the author (*Proc.*, 1893, 9, 109) obtained by the elimination of sulphuric acid from sulphocamphylic acid.

This same isolaunonic acid (together with a liquid acid, which is possibly an isomeride) is obtained when β -camphylic acid is reduced with sodium amalgam under certain conditions, and quite lately it has also been obtained in large quantity by fusing sulphocamphylic acid with soda in a cast-iron pot.

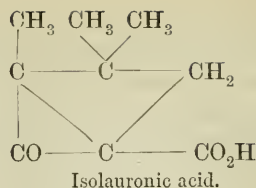
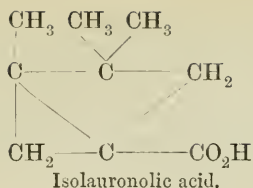
When fused in a nickel dish with caustic soda, sulphocamphylic acid yields a mixture of α - and β -camphylic acids, $C_9H_{12}O_2$, but when an iron pot is used, the iron acts as a reducing agent, and the product, which is found to contain quantities of ferric oxide, on treatment in the usual way yields large quantities of isolaunonic acid, $C_9H_{14}O_2$.

Isolaunonic acid is, as Koenigs and Meyer (*Ber.*, 1894, 27, 3466) showed, readily oxidised to isolaunonic acid, $C_9H_{12}O_3$, a ketonic acid which gives a well characterised oxime and a semicarbazide. On reduction with sodium amalgam, the author finds that isolaunonic acid is readily converted into *dihydroisolaunonic acid*, $C_9H_{14}O_3$ (m. p. 88°), a result differing somewhat from that of Koenigs and Meyer, who obtained in this way a lactone, $C_9H_{14}O_2$, melting at 47 – 50° , together with a substance melting at 80 – 81° , which they consider to be a mixture of two acids, $C_9H_{14}O_3$ and $C_9H_{16}O_3$.

The author has further studied the action of oxidising agents on isolaunonic acid, and finds that, under certain conditions, this acid is split up into dimethylsuccinic acid, $COOH \cdot C(CH_3)_2 \cdot CH_2 \cdot COOH$ and a ketonic acid, $C_8H_{14}O_3$, which melts at 51° .

This ketonic acid on oxidation is converted into $\alpha\alpha$ -dimethylglutaric acid, $CO_2H \cdot C(CH_3)_2 \cdot CH_2 \cdot CH_2 \cdot CO_2H$, and it therefore evidently has the constitution $CH_3 \cdot CO \cdot C(CH_3)_2 \cdot CH_2 \cdot CH_2 \cdot CO_2H$, and is identical with the acid previously obtained (*Proc.*, 1896, 12, 190), by oxidising β -camphylic acid.

A careful study of the results obtained in this long series of experiments on sulphocamphylic acid and the acids derived from it, seems to the author to clearly indicate that the constitutions of isolaunonic and isolaunonic acids are most probably represented by the following formulæ.



As sulphocamphylic acid on heating is resolved into isolaunonic acid and sulphuric acid, and on the other hand, isolaunonic acid, as was indicated in a previous communication (Proc., 1893, 9, 109) and has since been proved, when heated with sulphuric acid at 90°, is again converted into sulphocamphylic acid, it follows that the determination of the constitution of isolaunonic acid will throw most important light on the formula of sulphocamphylic acid, and on the remarkable changes which take place during the formation of this sulpho-acid from camphoric acid.

The discussion of these points and of their bearing on the constitution of camphoric acid, the author must reserve for a detailed description of his experiments, which he hopes soon to be able to lay before the Society.

ADDITIONS TO THE LIBRARY.

I. *By Purchase.*

Brande, W. T. Outlines of Geology; being the substance of a course of lectures delivered in the theatre of the Royal Institution in the year 1816. Pp. vii + 144. London 1817.

Frühling und Schulz. Anleitung zur untersuchung der für die Zucker-Industrie in betracht kommenden Rohmaterialien, Producte, Nebenproducte und Hülffssubstanzen. Fünfte, umgearbeitete und vermehrte auflage herausgegeben von Dr. R. Frühling. Pp. xvi + 465. Braunschweig 1897.

Hirsch, B., und Siedler, P. Die fabrikation der Künstlichen Mineralwässer und anderer moussirender Getränke. Dritte, neu bearbeitete auflage. Pp. xii + 393. Braunschweig 1897.

Hixon, H. W. Notes on Lead and Copper Smelting and Copper Converting. Pp. viii + 116. New York and London 1897.

Jettel, W. Die Zündwaaren-Fabrikation nach dem Heutigen Standpunkte. Pp. viii + 255. Wien, Pest, Leipzig 1897.

Lehmann, K. B., und Neumann, Rudolf. Atlas und Grundriss der Bakteriologie und lehrbuch der speciellen bakteriologischen diagnostik.

Teil I. Atlas, mit 558 farbigen abbildungen auf 63 tafeln und c. 70 bildern im text. Teil II. Text. Pp. vii + 448. München 1896.

Macé, E. *Traité pratique de Bactériologie*. Troisième édition mise au courant des travaux les plus récents avec 185 figures dans le texte. Première partie. Pp. i + 704. Paris 1897.

Menschutkin, N. *Analytical Chemistry*. Translated from the third German edition by James Locke. Pp. xii + 512. London 1896.

Moissan, Henri. *Le Four Électrique*. Pp. vi + 385. Paris 1897.

Moldenhauer, F. *Grundriss der Mineralogie für Löhre Lehrganstalten*. Pp. xviii + 262. Karlsruhe 1838.

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II. *Donations.*

Clowes, F., and Coleman, J. B. *Quantitative Chemical Analysis*. Fourth edition. Pp. xxiv + 583. London 1897.

From the Authors.

Fletcher, Thomas. *The Commercial Uses of Coal Gas*. Pp. 104. London 1897.

From the Author.

Harcourt, A. G. Vernon, and Madan, H. G. *Exercises in Practical Chemistry*. Fifth edition revised by H. G. Madan. Pp. xvi + 598. Oxford 1897.

From H. G. Madan, Esq.

Hewitt, J. T. *Organic Chemical Manipulation*. Pp. xi + 260, 63 illustrations. London 1897.

From the Author.

Mawe, J. *Instructions for the Management of the Blow-Pipe, and Chemical Tests*. 3rd edition. Pp. 71. London 1822.

From C. E. Franck, Esq.

Mendeléeff, D. *The Principles of Chemistry*, translated from the Russian (6th edition) by G. Kamensky. Edited by T. A. Lawson. Vol. I., pp. xviii + 621 ; vol. II., pp. 518. London 1897.

From the Editor.

Newth, G. S. *A Text-book of Inorganic Chemistry*. 5th edition. Pp. xv + 669. London 1897.

From the Author.

Sykes, W. J. *The principles and practice of Brewing*. Pp. xviii + 511. With plate and numerous illustrations. London 1897.

From the Author.

Walke, Willoughby. *Lectures on Explosives*. A course of lectures prepared especially as a manual and guide in the laboratory of the U.S. Artillery School. Pp. xvi + 435. 2nd edition New York 1897.

From the Author.

Wilson, G. *Inorganic Chemistry*. New edition revised and enlarged by H. G. Madan. Pp. v + 535. London 1897.

From H. G. Madan, Esq.

Williams, R. P. Elements of Chemistry. Pp. vi + 412. Boston 1897. From the Publishers.

Gabba, L. Manuale del Chimico e dell' industriale. Pp. xvi + 442. Seconda edizione. (Manuali Hoepli.) Milano 1898.

Gherzi, I. Leghe Metalliche ed Amalgame. Pp. xii + 431 con 15 incisioni. (Manuali Hoepli.) Milano 1898.

Vender, V. La Fabbricazione dell' Acido Solforico. Pp. v + 312 con 107 incisioni. (Manuali Hoepli.) Milano 1897.

From the Publishers.

Allen, Matthew. Outlines of a Course of Lectures on Chemical Philosophy. Pp. x + 70. London 1819.

Bergman, Torbern. Sciagraphia Regni Mineralis Secundum Principia Proxima Digesti. Editio prima Italica. Pp. 160. Florentiae 1783.

Davy, Humphrey. Outlines of a Course of Lectures on Chemical Philosophy. Pp. 54, and Sadler, John. An Explanation of the Terms used in Chemistry. Pp. 22. London 1804.

Dundonald, Earl of. A Treatise showing the Intimate Connection that subsists between Agriculture and Chemistry. Pp. vii + 252. London 1795.

Fourcroy, A. F. Éléments d'histoire naturelle et de Chimie. Cinquième édition. Vols. 1 and 5. Paris.

Oliver, William. A Practical Dissertation on Bath Waters. Pp. 136. London 1707. From S. G. Rosenblum, Esq.

Pamphlets.

Baker, R. T., and Smith, H. G. On the Presence of a True Manna on a "Blue Grass," *Andropogon annulatus*, Forsk. (Read before the Royal Society of N.S. Wales.) From the Authors.

Head, J. On Charging Open-hearth Furnaces by Machinery. Pp. 26. Reprint from the *Journal of the Iron and Steel Institute*, 1897.

From the Author.

Head, J. The Coal Industry of the South-eastern States of North America. Excerpt from the *Transactions* of the Federated Institution of Mining Engineers, 1897. From the Author.

Jones, L. J. W. Ferric Sulphate in Mine Waters, and its action on metals. Pp. 9. Read before the Colorado Scientific Society, June 5, 1897. From the Author.

Latham, P. W. On the Synthesis and Molecular Construction of the Dead and Living Proteid. Pp. 28. Cambridge 1897.

From the Publishers.

Long, J. H. On the Speed of Reduction of Ferric Alum by Sugar. Chicago 1897. From the Author.

Wardle, Sir Thomas, and Bell, P. Carter. On the Adulteration of

Silk by Chemical Weighting. Pp. 43. Read before the Society of Chemical Industry, April, 1897. From the Authors.

Wood, T. W. The Assay of Bullion, and Ellis, T. Flower. A Brief Account of the Malay Tin Industry. Chemical and Metallurgical Society of Johannesburg. February, 1897.

From T. J. McKillop, Esq.

At the next Meeting, on Thursday, November 18th, the following Papers will be received. The authors of those marked with an asterisk have announced their intention of being present.

* "On the decomposition of camphoric acid by fusion with potash or soda." By A. W. Crossley, M.Sc., Ph.D., and W. H. Perkin, jun., F.R.S.

"Experiments on the synthesis of camphoric acid." By W. H. Bentley, B.Sc., and W. H. Perkin, jun., F.R.S.

* "The action of magnesium on cupric sulphate solution." By Frank Clowes, D.Sc., and R. M. Caven, B.Sc.

* "Properties and relationships of dihydroxytartaric acid." By H. J. H. Fenton, M.A.

LIBRARY.

The attention of Fellows is called to the change of the hours during which the Library is open for consultation.

The Library is open for consultation and the issue of books from 10 a.m. to 6 p.m. (Saturdays 10 a.m. to 4 p.m.) and on the evenings of meetings from 7 p.m. to 9 p.m.

CERTIFICATES OF CANDIDATES FOR ELECTION.

N.B.—The names of those who sign from “General Knowledge” are printed in *italics*.

The following Candidates have been proposed for election. A ballot will be held on Thursday, December 2nd.

Annis, Ernest George,

Health Office, Town Hall, Huddersfield.

Physician and Surgeon (M.R.C.S. Eng., L.R.C.P. Lond., L.S.A. Lond., D.P.H., R.C.S. & P.). Medical Officer of Health and General Chemical Adviser to the Town Council of County Borough of Huddersfield.

Henry E. Roscoe.

S. G. Rawson.

Arthur P. Luff.

Frank Scudder.

Thos. Stevenson.

Henry Kenwood.

Ball, John, Ph.D., A.R.S.M.

18, Redshaw Street, Derby.

Engineer. Has studied Chemistry and Metallurgy for four years at the Royal College of Science, London, the Royal Saxon Mining Academy, Freiberg, and the University of Zurich. During a portion of the above time was engaged in research. Author of a paper dealing with the rate of solution of zinc in acids, *Proc. C.S.*, December 3rd, 1896; “Assaying at the Royal Saxon School of Mines,” *Mining Journal*, October, 1895; also “The Serpentine and Associated Rocks of Davos,” Zurich, 1897. Whitworth Scholar. De la Beche Medallist of the Royal School of Mines, London.

T. E. Thorpe.

W. C. Roberts-Austen.

W. Palmer Wynne.

A. Howard.

William A. Tilden.

Ball, William,

54, Stretton Road, Leicester.

Science Teacher. Teacher of Chemistry (Theoretical and Practical) for last eight years. For last six years, Teacher of Chemistry at the Alderman Newton's School, Leicester.

E. J. Cox.

Lewis Ough.

R. E. S. Richardson.

W. W. Fisher.

John Watts.

Beadle, Alec. Alfred,
Beadonwell, Belvedere, Kent.

Electro-Chemistry. Two years' course Electricity at Faraday House, Charing Cross; six months' course Analytical Inorganic Chemistry, under Mr. C. J. Wilson; three and a half years Assistant to Mr. James Swinburne, carrying on work of Chemical and Electro-chemical nature.

Chas. Fred. Cross.

Charles J. Wilson.

Clayton Beadle.

James Swinburne.

Dugald Clerk.

James Dewar.

Otto Hehner.

Edward Bevan.

Burland, Richard Oxley, J.P.,
Poolstock House, Wigan.

Manufacturing Chemist. Taken Certificates South Kensington. Member Society Chemical Industry. Manufacturing Chemist twenty years, Sulphate of Iron, Oxide of Iron, Oil, Paints, &c.

E. H. Saniter.

Arthur H. Tuer.

Wm. Jas. Orsman.

Arthur Carey.

Charles A. Kohn.

Cameron, Alexander McLean,
Daylesford, Victoria.

Director and Science Teacher School of Mines three years. Edinburgh University. Matriculated 1880, and attended usual courses of Chemistry, Botany, and Natural History for three years; also during same period attended the Chemical Laboratory of the Public Analyst to the City, J. Falconer King, and Extramural Lecturer; obtained Certificate of Merit. Melbourne University, 1891, obtained Certificate for Metallurgy (including Assaying). Government of Victoria, 1893, obtained highest grade Certificate for Chemistry, Metallurgy, and Assaying, with Honours in each, and the Education Department's Scholarships.

J. Dennant.

J. Falconer King.

Orme Masson.

C. R. Blackett.

A. W. Craig.

Clark, Owen Aly,
12, Abbeygate Street, Bury St. Edmunds.

Chemist. Associate Pharmaceutical Society Great Britain. Analytical and Consulting Chemist to Greene, King and Co., Limited, Westgate Brewery, Bury St. Edmunds. Analytical and Consulting Chemist to the Norwich Property Owners' Association.

Frank Browne.

Fredk. Johnson.

W. Watson Will.

Thomas Tyrer.

Arthur E. Barclay.

Clarkson, Alexander,

2, Waveney Crescent, Ballymena, Ireland.

Analytical Chemist. The Antrim Iron Ore Co., Ltd., Belfast. Seven years' experience as an Analytical Chemist. Two years as a Student, and 5 years as Assistant Chemist in the Laby's Parkhead Forge, Glasgow, and L.S. Co. Ltd., Motherwell.

R. R. Tatlock.

A. Humboldt Sexton.

John A. Craw.

Geo. Ritchie.

H. W. Dickinson.

Collingridge, Frank,

"Kenmore," Shepherd's Hill, Highgate, London, N.

Chemical Research Student. Bachelor of Science (London, 1895) Chemistry, Physics, Mathematics. Associate of Institute of Chemistry (1896).

William Ramsay.

N. T. M. Wilsmore.

Morris W. Travers.

J. Norman Collie.

J. Wallace Walker.

A. M. Kellas.

Crofts, James Murray,

"Richleigh," Gloucester.

Research Student of Emmanuel College. B.A. Emmanuel College, Cambridge. First Class Nat. Sciences Tripos Part I.; 2nd. Class Nat. Sciences Tripos, Part II. (Chemistry and Physiology). Inter. Science (London): Scholar of Emmanuel College.

G. D. Liveing.

W. J. Sell.

H. J. H. Fenton.

M. M. Pattison Muir.

S. Ruhemann.

R. S. Morrell.

George Embrey.

Crole, David,

Primrose Studios, Wellington Square, Chelsea, S.W.

Author. Carried out researches in India, &c., in the Chemistry of Tea; read a paper on that subject before the Society of Arts this year, and also written a technical work on "Tea." Have been a Student under, or worked in, the Laboratories of Professors Drinkwater, Page, Bayne, &c.

James Bayne.

Frederic Jas. M. Page.

Hubert E. Lindley.

H. Wilson Hake.

M. Kelway Bamber.

Daniell, John,

Council of Education Laboratory, Johannesburg, S.A.R.

Lecturer in Chemistry and Assaying to Witwatersrand School of Metallurgy. For 18 years Head Chemist and Head Assayer to Messrs. Nevill, Druce & Co., Llanelly, S. Wales. Lecturer in Chemistry

etc., at Llanelly under S. and A. Department. Now Director of the Witwatersrand School of Metallurgy.

Robert Wallace.

Lionel. M. Jones.

John R. Morgan.

J. Falconer King.

George Beilby.

Dixon, Andrew James,

Dapto, N.S.W.

Head Chemist and Assayer to the Smelting Company of Australia. Three years a student at the Glasgow and West of Scotland Technical College with Profs. Mills and Dittmar. Passed as an Associate of the Institute of Chemistry in 1891, and became a Fellow in 1896. Studied Metallurgy for 1 year at the Royal School of Mines. Worked $3\frac{1}{2}$ years as analyst with W. A. Dixon in Sydney. At present Head Chemist and Assayer to the Smelting Company of Australia.

Will. A. Dixon.

William M. Hamlet.

Alexander Orr.

Henry G. Smith.

A. J. Bersusan.

Guttmann, Oscar, Assoc. M. Inst. C.E., F.I.C.,

12, Mark Lane, London, E.C., and 18, Aberdare Gardens, N.W.

Consulting Engineer, engaged in the management and erection of explosives and chemical works for the last 23 years, author of various books and contributions to periodicals on explosives and other matters, member of council of the Society of Chemical Industry, etc., etc.,

Otto Hehner.

John A. R. Newlands.

John Heron.

Rudolph Messel.

Arthur R. Ling.

C. A. Mitchell.

B. E. R. Newlands.

Hamilton, Robert,

11, Ibrox Place, Glasgow.

Science Teacher. Bellahouston Academy, Govan, Glasgow. Eight years Teacher of Chemistry and Physiography in above school. Certificated by Science and Art Department in Inorganic Chemistry (first Honours), Organic Chemistry, Physiography, Magnetism and Electricity, Geology, Mathematics (Glasgow University).

R. R. Tatlock.

James Craig.

Hugh Manners.

James Robson.

William Ralston.

Thomas Gray.

John Wm. Biggart.

Harger, John,

The Nook, St. James' Mount, Liverpool.

I studied three years at University College, Liverpool, and took degree of B.Sc. with Honours in Chemistry in Victoria. Worked for

eighteen months at Heidelberg University, and took degree of Ph.D. Research on Succinic Acid Derivatives. Worked with Professor P. E. Frankland at Mason College, for one year, as Priestley Research Scholar—Research on Tartaric Acid Derivatives. I am an Associate of Institute of Chemistry of Great Britain and Ireland.

J. Campbell Brown.

Charles A. Kohn.

R. E. Kenyon.

Andrew Turnbull.

W. R. Innes.

Horseman, James Walter,

5, South Parade, Chelsea, London, S.W.

Demonstrator to Drs. Moritz and Morris, of 72, Chancery Lane. Intermediate Science, London. Two years' study at University College of North Wales, Bangor. One and half year's study at University College, London. Private Assistant to Professor Ramsay before holding present post.

William Ramsay.

John Shields.

Morris W. Travers.

N. T. M. Wilsmore.

J. Norman Collie.

Geo. W. MacDonald.

Kelly, Charles,

Oakmere, Hawarden, Chester.

Science Teacher. 1883—93, Assistant Master; 1893—96, Exhibitioner, Royal College of Science, London; 1896 to present, Science Master.

William A. Tilden.

W. Palmer Wynne.

Chapman Jones.

Martin O. Forster.

James Bruce.

Lemmey, Tom,

Wellington College, Berks.

Assistant Master. B.A. Oxon. Honours School of Natural Science (Chemistry). Second Science Master at Wellington College.

H. Purefoy Fitzgerald,

V. H. Veley.

W. W. Fisher.

E. W. T. Jones.

John Watts.

J. E. Marsh.

Maclaurin, James Scott,

Mount Eden, Auckland, N.Z.

Analytical Chemist. Author of the following papers in the *Transactions* of the Chemical Society: "The Dissolution of Gold in a Solution of Potassium Cyanide," 1893; "The Action of Potassium Cyanide Solutions on New Zealand Gold and Silver," 1895; "The Relative Weights of Gold and Silver dissolved by Potassium Cyanide

Solutions from Alloys of those Metals," 1896 ; "Double Sulphides of Gold and other Metals," 1896. B.Sc. 1891 ; First Class Honours 1892 ; D.Sc. 1897 ; all of New Zealand University. Science Scholarship of Royal Commission for 1851 Exhibition gained in 1895.

Fred D. Brown.

Henry E. Armstrong.

J. A. Pond.

A. Vernon Harcourt.

James Mactear.

Claude Vautin.

D. A. Sutherland.

Macmullen, Alan,

82, James Street, Dublin.

Brewer at Messrs. A. Guinness, Son and Co., Ltd. Natural Science Scholar at Balliol College, Oxford. First Class in Chemistry, Natural Science School. Science Master at Wellington College, Berks. Is studying the science and practice of brewing.

A. Vernon Harcourt.

John Conroy.

D. H. Nagel.

Wm. Odling.

W. W. Fisher.

Mansford, Charles John Jodrell, B.A. London,

Lady Manners Grammar School, Bakewell.

Headmaster. Headmaster of Lady Manners Grammar School and Organised Science School. Engaged in teaching Chemistry since 1884.

A. S. Waterfield.

William G. Boul.

R. W. Buttemer.

Samuel Rideal.

G. E. Scott Smith.

Masters, Edward,

The Aloes, Hinckley Road, Leicester.

Science Teacher. Associate of the Royal College of Science, London (in Chemistry). Now Teacher of Chemistry and Physics at Alderman Newton's Higher Grade Science School, Leicester.

William A. Tilden.

G. S. Newth.

Chapman Jones.

W. Palmer Wynne.

James Bruce.

Mathews, John A.,

4, First Place, Brooklyn, N.Y.

Fellow in Chemistry, Columbia University, N.Y. Washington and Jefferson College (B.S. and M.S.) Three years Post-graduate in Columbia University (M.A.). Assistant in Assaying and Quantitative in Columbia, 1896—7 ; Fellow-Elect in Chemistry, 1897—8. Publications in journals :—*School of Mines Quarterly* (1894), "Carborundum" ; *J. Amer. Chem. Soc.* (1896), "Phthalimid" ; *J. Amer. Chem. Soc.* (1896), "Table of Factors" (with E. H. Miller) ; *J. Amer. Chem. Soc.* (1897), "On the Ferrocyanides of Zn and Mn" (with Dr. Miller) ; Lectured

to Brooklyn Institute of Arts and Sciences (1896). An extended *Review and Bibliography* (600 references) of the *Metallic Carbides* was recommended to the Smithsonian Institution for publication, and accepted by that Institution. It has not yet been published. The "Committee on Indexing Chemical Literature" of the American Association for the Advancement of Science which thus approved and recommended my work consisted of H. Carrington Bolton, H. W. Wiley, Francis W. Clarke, A. R. Leeds, A. B. Prescott, and Alfred Tuckerman.

Charles F. Chandler.	Peter T. Austen.
Jas. S. C. Wells.	H. T. Vulté.
James H. Stebbins, Jun.	<i>Thos. P. Wiltshire.</i>
<i>S. A. Goldschmidt.</i>	<i>J. H. Wainwright.</i>
<i>V. Coblenz.</i>	<i>Wm. Jay Schieffelin.</i>

Moon, Philip George Gregory,

129, Rosary Road, Thorpe, Norwich.

Chemist in charge, British Gas Light Company, Norwich.
Chemist to the British Gas Light Company. Formerly student for 3 years at the East London Technical College. Assistant Chemist for 3 years at Messrs. Martineau's sugar refinery, London; 1st Honours and Medal, Inorganic Chemistry, South Kensington, 1894.

Sydney Steel.	J. Theo. Hewitt.
Francis Sutton.	A. P. Laurie.
<i>F. Napier Sutton.</i>	<i>Bernard Dyer.</i>

Mooney, Joseph John,

34, Easter Road, Edinburgh.

Surgeon and Apothecary. L.S.A. London, L.A.H. Dublin, worked for 6 months in the Pharmaceutical Laboratory of Owens College under Mr. Wm. Elborne, and for 6 months in the Laboratory of Mr. King, Edinburgh, City Analyst. Author of "Chemical Processes relating to Water, Air, Food, and Drugs." In course of publication by Thin, Edinburgh.

William Elborne.	J. Falconer King.
Eugen Blume.	<i>J. Watson Napier.</i>

G. H. Gemmell.

Philip, James Charles,

16A, Merton Road, Victoria Road, Kensington, W.

Student. Graduated B.Sc. at Aberdeen University, 1895; Ph.D. of Göttingen, 1897. Published in the *Zeitschrift für physik. Chemie*, September, 1897, article on "Das dielectrische Verhalten flüssiger Mischungen."

F. R. Japp.	T. S. Murray.
Henry E. Armstrong.	F. Stanley Kipping.
Gerald T. Moody.	

Reid, Alexander Ferguson,

Stair Bridge, Stair, Ayrshire.

Technical Chemist. (1) Some time Chemical Assistant to Hugh Dickie, B.A., LL.D., of Kilmarnock. (2) Three years in the laboratories of Messrs. Wallace, Tatlock and Clark, City Analysts, Glasgow. (3) Studied Chemistry at the Glasgow and West of Scotland Technical College under Professor A. H. Sexton F.R.S.E., F.I.C., ; Professor G. G. Henderson, D.Sc., M.A., F.I.C., ; Professor A. Schloesser, Ph.D., M.Sc. F.I.C. (4) Five years Chemist to the Cassel Gold Extracting Company of Glasgow. (5) Nearly three years Chemist to Mr. Montgomerie, Stair, N.B. (6) Contributions to Chemical Literature:—*Chemical News*, vol. 57, p. 39, vol. 65, pp. 68, 125 ; vol. 66, p. 166 ; vol. 67, p. 159, &c. *Zeitschrift für analytische Chemie*, vol. 32, part 4. *Journal of the Chemical Society*, 1892, p. 1027 (Abstracts).

G. G. Henderson.

Wm. Rintoul.

Horatio Ballantyne.

John Clark.

R. R. Tatlock.

John S. MacArthur.

A. Humboldt Sexton.

Roberts, Ernest Henry,

Hollydale, Allfarthing Lane, Wandsworth, S.W.

Chemist, Dairy Supply Company, Limited. Two and a half years Liverpool College of Chemistry, 7 years assistant to Dr. Bernard Dyer.

Bernard Dyer.

Sydney Steel.

Otto Hehner.

Edward Bevan.

J. F. H. Gilbard.

Charles E. Cassal.

Simpson, Edward Sydney, B.E.

34, Pier Street, Perth, West Australia.

Government Mineralogist and Assayer. Student Mining School University of Sydney, 1892—1895 ; 1st Honours and Slade Prize for Chemistry, 1893 ; 1st Honours and Caird Scholarship for Chemistry, 1894 ; Bachelor of Engineering with Honours, 1895 ; Researches on Russell Process in 1895 ; Assistant Assayer and Acting Analyst, Mt. Morgan G.M. Co., 1896—97.

A. Liversidge.

J. A. Schofield.

James Taylor.

John C. H. Mingaye.

John M. Thomson.

Smith, Robert Francis Wood,

89, Bartholomew Close, E.C.

Bacteriologist and Consulting Chemist. Special Chemistry Course (three years) at City Guilds Technical College at South Kensington.

Late private assistant to Prof. A. A. Kaultack at St. Bartholomew's Hospital Path. Lab.; author of paper, "Vibrio Tonsillaris," *Centralblatt für Bakteriologie*, etc.

Gerald T. Moody.

F. Stanley Kipping.

Julian L. Baker.

R. C. T. Evans.

Henry E. Armstrong.

Arthur R. Ling.

Southern, Thomas, Junr.,

2, Cherry Mount, The Cliff, Higher Broughton, Manchester.

Manufacturing Chemist. Studied Chemistry, 1883—1886, under Mr. Wilson, of Manchester Grammar School, and 1886 under Mr. G. H. Hurst, Analytical and Consulting Chemist, Manchester. Subsequently 2 years at Owens College, Manchester. Now Chemist to the Wheathill Chemical Works, Salford, where I have had inside management of the works and superintendence of various alterations and improvements during the past 6 years. Member of the Society of Chemical Industry.

Christopher Wilson.

George H. Hurst.

J. Carter Bell.

George J. Allen.

R. J. Flintoff.

Steel, Frederick William,

Tamunua, Navua River, Fiji.

Analytical Chemist. Student, Science and Art Dept., local (Glasgow and Greenock) Classes. Student under Prof. J. M. Milne, Ph.D., F.I.C. (St. Mungo's College, Glasgow). Student under Prof W. Dittmar, LL.D., F.R.S. (G. & W. S. Technical College). Three years Chemist to the Fiji Sugar Co., Ltd., and at present still holds this position.

Thos. Steel.

T. U. Walton.

T. L. Patterson.

John Wm. Biggart.

Geo. Patterson.

Stephens, Michael Edmund,

Avenue House, Finchley.

Writing Ink Manufacturer, partner in the firm of Henry C. Stephens of Aldersgate Street. The Candidate has had the Technical Management and direction of the laboratory and works for the past 11 years.

James Dewar.

Henry E. Armstrong.

William Crookes.

Henry C. Stephens.

John A. R. Newlands.

Boverton Redwood.

E. Frankland.

F. A. Abel.

Stubbs, George,

Arnside, Hertford Road, East Finchley, N.

A Student at the Royal College of Science, 1887-8. Analyst in the Government Laboratory, London. For seven years assistant teacher of Organic Chemistry at the Birkbeck Institution.

T. E. Thorpe.

R. Bannister.

H. J. Helm.

E. Grant Hooper.

J. Woodward.

C. Proctor.

Tripp, Edward Howard,

Kent House, Blackheath Hill, S.E.

Ph.D. (Marburg). Four-and-a-half years' study in Germany. Joint author with Prof. Zincke of an original investigation of "Ketobromides in the asym. Xylenol series," Member of the "Deutsche Chemische Gesellschaft," Honorary Demonstrator at the Central Technical College, City and Guilds of London Institute.

Thomas Tyrer.

Wm. Martindale.

Henry E. Armstrong.

Aug. Schloesser.

Rudolph Messel.

David Howard.

Turner, John Scriven,

20, Bury Street, Bloomsbury, London, W.C.

Assistant to J. Kear Colwell, Esq., Public Analyst, Clerkenwell Town Hall, Rosebery Avenue, London, E.C. Studied Chemistry at University College School under Temple Orme, Esq., and for two years in the laboratories of the Pharmaceutical Society under Professors W. R. Dunstan, F.R.S., F.I.C., and J. Attfield, F.R.S., F.I.C. For the past twelve months assistant to J. K. Colwell, F.I.C., Public Analyst for St. Giles', Holborn and Clerkenwell.

J. Kear Colwell.

Wyndham R. Dunstan.

John Attfield.

J. Norman Collie.

Charles E. Cassal.

Viccajee, Framjee Khurshedjee,

Hyderabad, Deccan (India), H.H. the Nizam's State.

Hyderabad Civil Service, H.H. the Nizam's Mint. Studied Chemistry at the Nizam's College, Hyderabad, Deccan (India) (2 years' course) served probation at the Assay Office, Bombay Mint, for about 12 months. In charge of Assay Work at H.H. the Nizam's Mint (1894-96); went through a course of Metallurgy and Assaying at the Royal School of Mines (1896-97), London.

W. C. Roberts-Austen.

Henry C. Jenkins.

Ernest A. Smith.

F. W. Bayly.

T. K. Rose.

Vinter, Percy John,

Wesley College, Sheffield.

Schoolmaster. Second Class Science Tripos, 1893, Cambridge; Chemistry one of the three subjects taken. Further work done in Organic preparations in the University Laboratories. Now Senior Science Master, Wesley College, Sheffield; formerly Science Master, Blairlodge School, Scotland.

S. F. Dufton.

Alexander Scott.

F. L. Overend.

W. Carleton Williams.

G. T. W. Newsholme.

While, Arthur James,

Whinsfield, Barrow-in-Furness.

Analytical Chemist. First Class Metallurgy and Assaying School of Mines, London. Eighteen months Head Chemist to Barrow Hematite Steel Co.

W. C. Roberts-Austen.

F. W. Bayly.

T. K. Rose.

Ernest A. Smith.

Henry C. Jenkins.

Young, Francis Samuel,

Mill Hill School, London, N.W.

Science Master, Mill Hill School; M.A. Oxon. Degree in Final Honour, School of Chemistry. Research with Dr. Ruhemann in 1894. Teacher and Lecturer on Chemistry at Mill Hill School, London, N.W., since 1894.

V. H. Veley.

W. W. Fisher.

J. E. Marsh.

John Watts.

J. Addyman Gardner.

S. Ruhemann.

PROCEEDINGS
OF THE
CHEMICAL SOCIETY.
EDITED BY THE SECRETARIES.

No. 184.

Session 1897-8.

November 18th, 1897. Professor Dewar, F.R.S., President, in the Chair.

Messrs. W. J. Elliott, H. S. Elworthy, F. F. de Morgan, Frank Moul, A. Harden, and Charles E. Browne were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. Cecil Joslin Brooks, 24, Wood Street, Woolwich; Charles Henry Burge, Iddesleigh Crescent Road, Kingston Hill, S.W.; M. J. Cannon, 101, The Chase, Clapham Common, S.W.; William Ranson Cooper, M.A., B.Sc., 87, Upper Tulse Hill, S.W.; Frederick Robertson Dodd, 1, Wesley Street, Liverpool; Jules Fuerst, 23, Marlborough Road, N.W.; James Brown Reid, 6, Southfield Terrace, Skepton; Harold Charles Sayer, Devon Villa, Summerhill Road, Dartford.

The PRESIDENT announced that he had received a letter from Sir Fleetwood Edwards stating that he had been commanded by the Queen to forward to him a Medal in commemoration of the 60th Anniversary of Her Majesty's reign.

Of the following papers those marked * were read.

- *118. "On the decomposition of camphoric acid by fusion with potash or soda." By Arthur W. Crossley and W. H. Perkin, jun.

The authors find that by the action of fused potash on camphoric acid a very complicated mixture of acids is obtained. The volatile portion consists of acetic, propionic, isobutyric, isovaleric and

methylisopropylacetic acids, together with acids of the formulæ $C_6H_{13}CO_2H$, $C_7H_{15}CO_2H$ and $C_8H_{17}CO_2H$, of which the constitution is doubtful. The non-volatile acids consist of pimelic (isopropylsuccinic) acid and a new substance, dihydrocamphoric acid.

Dihydrocamphoric acid, $C_{10}H_{18}O_4$, crystallises in nodular masses melting at $105-106^\circ$, and on oxidation with dilute nitric acid yields succinic acid, oxalic acid, and an acid of the formula $C_8H_{14}O_4$, which is in all probability the $\alpha\beta\beta$ -trimethylglutaric acid described by B.

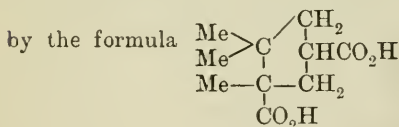
On treatment with acetic anhydride, dihydrocamphoric acid is converted into its anhydride, which, when heated to boiling, decarboxylates with elimination of carbon dioxide and formation of a cyclic ketone of the formula $C_9H_{16}O$. *Dihydrocamphoketone* is a liquid boiling at $180-181^\circ$ and smelling strongly of peppermint. It forms a liquid ketoxime and a semicarbazone melting at $202-203^\circ$.

The results obtained on fusing camphoric acid with caustic soda differ markedly from the above. The lower volatile fatty acids appear to be the same as those obtained from caustic potash, but there is also present an unsaturated acid of the formula $C_8H_{15}CO_2H$.

The acids not volatile in steam consist of large quantities of pimelic acid and some unchanged camphoric acid, together with two new acids, pseudocamphoric acid, $C_{10}H_{16}O_4$ and an acid of the formula $C_9H_{16}O_4$, boiling at $254-257^\circ$ at 50 mm.

Pseudocamphoric acid crystallises from water in colourless, six-sided plates with bevelled edges, usually grouped together in the form of stars, and melts at $119-120^\circ$. It forms a crystalline anhydride melting at $52-53^\circ$ and an anilic acid melting at 208° . A further difference from its isomeride *d*-camphoric acid is that when treated with sulphuric acid it does not evolve carbon monoxide forming a sulphonic acid.

The authors explain the results of the action of fused alkalis on camphoric acid and deduce constitutional formulæ for the various compounds obtained on the assumption that camphoric acid is represented



*119 "Experiments on the synthesis of camphoric acid." By W. H. Bentley and W. H. Perkin, jun.

The authors have attempted to prepare an acid of the constitution suggested (Proc., 1896, 12, 189) as a probable formula for camphoric acid (see preceding abstract). They prepared isobutylmethylhydroxy-

glutaric acid, $\text{Me}_2\cdot\text{CH}^*\cdot\text{CH}_2\cdot\text{CH}(\text{CO}_2\text{H})\cdot\text{CH}_2\cdot\text{C}(\text{CO}_2\text{H})\text{Me}\cdot\text{OH}^*$, but did not succeed in eliminating water in the direction desired (at the points * *), the product in most of the experiments being the lactone-acid, $\text{Me}_2\cdot\text{CH}\cdot\text{CH}_2\cdot\underset{\text{CO}}{\underset{|}{\text{CH}}}\cdot\text{CH}_2\cdot\underset{\text{O}}{\underset{|}{\text{C}}}\cdot\text{Me}\cdot\text{CO}_2\text{H}$, or one of its derivatives

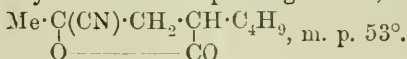
Following substances were prepared during the course of the

bromisobutylacetate, $(\text{Me}_2)\cdot\text{CH}\cdot\text{CH}_2\cdot\text{CHBr}\cdot\text{CO}_2\text{Et}$, an oil b. 100—103° (17 mm.).

Ethylic acetylisobutylsuccinate, $\text{Me}_2\cdot\text{CH}\cdot\text{CH}_2\cdot\underset{\text{Me}\cdot\text{CO}\cdot\text{CH}\cdot\text{CO}_2\text{Et}}{\underset{|}{\text{CH}}}\cdot\text{CO}_2\text{Et}$, prepared by

the action of ethylic bromisobutylacetate on ethylic sodioacetoacetate. It is a colourless oil boiling at 160° (25 mm.), and when hydrolysed with dilute hydrochloric acid or sulphuric acid yields *isobutylsuccinic acid*, $\text{Me}_2\cdot\text{CH}\cdot\text{CH}_2\cdot\text{CH}(\text{CO}_2\text{H})\cdot\text{CH}_2\cdot\text{CO}_2\text{H}$, m. p. 109°. When hydrolysed with concentrated hydrochloric acid, however, *isobutyllevulinic acid*, $\text{Me}_2\cdot\text{CH}\cdot\text{CH}_2\cdot\text{CH}(\text{CO}_2\text{H})\cdot\text{CH}_2\cdot\text{COMe}$, is formed. This is a colourless oil boiling at 190° (30 mm.), and yielding a semi-carbazone melting at 192°: bromine, in the presence of potash, oxidises it to isobutylsuccinic acid.

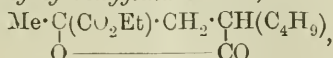
Isobutyllevulinic acid readily unites with hydrogencyanide, forming *isobutylhydroxycyanovaleic acid*, $\text{Me}\cdot\text{C}(\text{OH})(\text{CN})\cdot\text{CH}_2\cdot\text{CH}(\text{C}_4\text{H}_9)\cdot\text{CO}_2\text{H}$, which crystallises with $1\text{H}_2\text{O}$ in needles melting at 95—96°. This acid on distillation yields the corresponding lactone,



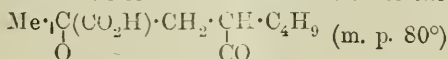
When an alcoholic solution of the hydroxy-cyano acid is saturated with hydrogen chloride, it is hydrolysed and converted into the ethereal salt of *isobutylmethylhydroxyglutaric acid*,



on distillation, this loses alcohol, forming the ethereal salt of the lactone of *isobutylmethylhydroxyglutaric acid*,



which is an oil boiling at 168° (17 mm.). This on hydrolysis with alcoholic potash is converted into *isobutylmethylhydroxyglutaric acid*, $\text{Me}\cdot\text{C}(\text{OH})(\text{CO}_2\text{H})\cdot\text{CH}_2\cdot\text{CH}(\text{C}_4\text{H}_9)\cdot\text{CO}_2\text{H}$, a crystalline acid melting at 134° with elimination of water and formation of the lactone,



*120. "Synthesis of an isomeride of camphoronic acid."

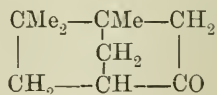
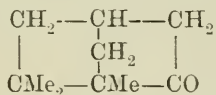
By S. B. Schryver, Ph.D.

The compound, $\text{CO}_2\text{H} \cdot \text{CH}(\text{Me})\text{CH}_2 \cdot \text{C}(\text{CH}_2 \cdot \text{CO}_2\text{H})(\text{Me}) \cdot \text{CO}_2\text{H}$, was synthesised by acting on methylacrylic ester, $\text{CH}_2 \cdot \text{C}(\text{Me})\text{CO}_2\text{Et}$, with sodiomethylmalonic ester. The addition product thus obtained, having the formula $(\text{CO}_2\text{Et})_2\text{C}(\text{Me}) \cdot \text{CH}_2 \cdot \text{CNa}(\text{Me})\text{CO}_2\text{Et}$, instead of being isolated, was acted on by iodacetic ester. Among the resulting products was the compound $(\text{CO}_2\text{Et})_2\text{C}(\text{Me})\text{CH}_2 \cdot \text{C}(\text{CH}_2 \cdot \text{CO}_2\text{Et})(\text{Me}) \cdot \text{CO}_2\text{Et}$, which on hydrolysis gave an acid of the required formula. This was isolated by means of its lead salt, which is insoluble in acetic acid, in the form of a syrup, and this on treatment with nitric acid gave a crystalline oxy-acid having the formula $\text{C}_9\text{H}_{14}\text{O}_7$. It is, therefore, an isomeride of camphoronic acid.

DISCUSSION.

Dr. KIPPING said that it was very difficult to criticise papers which, like those read by Dr. Crossley, contained so many new and important facts relating to substances of somewhat complex constitution. It seemed to him, however, that all the results obtained by Dr. Crossley and Dr. Perkin in their study of the substances produced by fusing camphoric acid with potash, could be explained on the basis of Bret's formula; such an opinion might of course be altered after carefully examining the details of the work as laid out in the published papers.

Dr. FORSTER pointed out that the formula for camphoric acid employed by Drs. Crossley and Perkin appears to involve the expression of the constitution of camphor by one of the formulæ



The behaviour of camphoroxime on dehydration, and the isomerism of two series of campholenic derivatives, seem to render the second expression the more probable of the two, but before either could be accepted, an explanation must be furnished of the changes involved in the production of such compounds as cymene and carvacrol from camphor—changes which, it must be remembered, are readily explained by Bret's formula.

The production of the acid, $\text{CHMe}_2 \cdot \text{CH}_2 \cdot \text{CH}_2 \cdot \text{CH}_2 \cdot \text{CHMe} \cdot \text{CO}_2 \cdot \text{H}$, obtained by the authors by fusing camphoric acid with alkali, harmonises with the new camphoric acid formula, but it must not be overlooked that Bret's formula for camphoric acid affords an equally plausible explanation.

Dr. CROSSLEY, in reply, said that the main evidence for accepting the formula proposed by Professor Perkin was embodied in his paper on sulphocamphylic acid, which had not yet been published in detail. Whilst the production of most of the compounds described by Professor Perkin and himself admit of explanation by Bredt's formula, it does not account for the formation of $\alpha\alpha\beta\beta$ -tetramethyladipic (dihydro-camphoric) acid.

***121. "The action of magnesium on cupric sulphate solution." By Frank Clowes, D.Sc., and R. M. Caven, B.Sc.**

The authors have examined the action of magnesium on solutions of cupric sulphate of different strengths, both at atmospheric temperature and at a temperature near their boiling point. They find that the evolution of hydrogen which always takes place is accompanied by the precipitation of a mixture of cuprous oxide and metallic copper in proportions which vary with the conditions of the experiment.

When a dilute solution of cupric sulphate is employed, the above mentioned products are accompanied by a quantity of a green substance, which consists of a mixture of basic hydrated sulphates of copper and magnesium. This substance was observed to form when a saturated solution of cupric sulphate was employed, but it was decomposed again before the reaction was completed.

The time of the reaction varies from ten minutes in the case of a hot strong solution of cupric sulphate to several days, or even a week, when a dilute solution is employed at atmospheric temperature.

The quantities of the three reduction products, cuprous oxide, copper, and hydrogen, were determined under various conditions. A volumetric process depending upon the use of potassium permanganate was employed for the estimation of the cuprous compound when it occurred together with the basic sulphate of copper and magnesium before mentioned.

The authors found in each case which they investigated that the sum of the magnesium equivalents of the cuprous oxide, copper, and hydrogen obtained agrees very closely with the amount of magnesium employed in the experiment. The magnesium is therefore proved to have displaced from the solution of cupric sulphate, substances which are chemically equivalent to it, though only a small and variable proportion of these substances consists of metallic copper. The authors have shown that the nature of the reaction is not influenced by the presence of slight impurities in the cupric sulphate employed by carrying out similar experiments with a specimen of the salt obtained by six successive recrystallisations of a sample which was originally almost pure. Pickering's observation of the formation of a

basic sulphate of copper by the decomposition of a solution of cupric sulphate by boiling, has been incidentally confirmed, but the formula which the authors attribute to this compound is $4\text{CuSO}_4, 7\text{Cu}(\text{OH})_2, \text{H}_2\text{O}$.

NOTE—24th November.—The authors have now referred to the paper by Commaille (*C. R.*, 1866, 63, 556), and they find that an equation is given which is supposed to represent the reaction between magnesium and cupric sulphate solution. This equation, when it is put into modern form and corrected for an obvious error, reads as follows: $6\text{CuSO}_4 + 5\text{Mg} + 3\text{H}_2\text{O} = 5\text{MgSO}_4 + (3\text{CuO}, \text{SO}_3) + \text{Cu}_2\text{O} + \text{Cu} + 3\text{H}_2$.

No details are given as to the temperature or the strength of the cupric solution which acted on the magnesium, nor are the analytical data stated upon which the above equation is founded. It will be noticed that the formation of basic magnesium compounds is not accounted for in the above equation. The authors consider that the results of their own analyses and examination prove that the composition of the basic sulphate of copper is variable, but that it does not correspond to the above formula, and certainly occurs in the condition of hydroxysulphate. They have never found that the proportion between the quantities of cuprous oxide and metallic copper is such as can be definitely represented by means of an equation, but rather that it varies within wide limits under different experimental conditions.

It will therefore appear that Commaille's imperfect study and statement of the reaction may well be supplemented by a more complete investigation.

The authors desire to place on record the fact that, when zinc acts upon a cold solution of copper sulphate, small bubbles of gas are evolved; and that when a hot solution of cupric salt is employed, an appreciable quantity of hydrogen can be collected, and cuprous oxide is found in the residue. They intend to study this reaction in detail.

DISCUSSION.

Professor TILDEN remarked that the work of the authors had been anticipated by the experiments of Commaille, who had published thirty years ago the results of an inquiry into the action of magnesium on neutral metallic salts, including copper sulphate.

When magnesium is immersed in an aqueous solution of copper sulphate free from acid, the action seemed to take the following course. First, there was a precipitation of spongy, metallic copper, which, in contact with the magnesium, gave a couple capable of decomposing water at common temperatures. Hydrogen was then evolved, and a crust of magnesia formed on the surface of the metal. The copper

salt was locally reduced by the hydrogen to the cuprous state, and this, in the presence of the magnesium oxide, led to the precipitation of cuprous oxide and of a basic cupric salt. The green precipitate formed therefore consists of magnesia and basic cupric salt, the proportion varying according to the temperature and strength of the solution. This hypothesis is borne out completely by the results both by Commaille and the authors of the paper, and serves to account for the apparent inactivity of the magnesium which is mechanically protected by the crust which forms upon its surface. The speaker had tested the suggestion that the metal was rendered inactive by a film of hydrogen and had come to the conclusion that this was not the case.

Professor CLOWES said that the origin of the investigation dated back some two years, the irregular action of magnesium on the cupric solution having been noticed in the course of experiments made in connection with a laboratory curriculum which he was then drafting for elementary students. It was anticipated that the reaction of magnesium on cupric sulphate might serve to establish the relative chemical values of copper and magnesium, but this was found to be impracticable owing to the evolution of a large amount of hydrogen. If such irregular actions occurred, instead of the simple replacement of one metal by another in solutions of its salts, it would seem that this method of determining chemical equivalents was not of general application.

Mr. CAVEN, in reply, said he regretted that he had overlooked the paper by Commaille on this subject to which Dr. Tilden referred.

It seems improbable that cuprous salt is formed by the reducing action of nascent hydrogen upon the cupric salt in the solution. This would lead to the formation of free sulphuric acid, which would decompose the cuprous oxide formed at the commencement of the reaction into cupric sulphate and metallic copper. If nascent hydrogen reduces the cupric salt at all, it can only produce metallic copper. Sulphuric acid would be liberated in this case also, though not in immediate contact with cuprous oxide. It may be that the process of solution of the magnesium hydroxide and basic copper salt which occurs at the close of the reaction in concentrated solutions, depends upon the action of the free acid thus produced.

The authors suggest that the magnesium reduces the cupric solution directly, producing cuprous oxide and hydrogen in the following manner, the proportion of the hydrogen evolved in the gaseous state being dependent upon the conditions of the experiment: $2\text{Mg} + 2\text{CuSO}_4 + \text{H}_2\text{O} = 2\text{MgSO}_4 + \text{Cu}_2\text{O} + \text{H}_2$.

Some such reaction as this, proceeding simultaneously with the action of the couple, may account for the immediate formation of cuprous oxide,

and the vigorous evolution of hydrogen at the moment of immersion of the magnesium. The action of the magnesium-copper couple on the water is not in itself sufficient to account for the very large quantity of hydrogen which is obtained, or for the rapidity with which it is produced, since, when the couple acts upon pure water, the hydrogen is evolved only very slowly. This view of the origin of the cuprous oxide is borne out by the fact that it occurs, together with metallic copper, quite from the commencement of the reaction, and that the formation of hydrogen appears to begin directly the magnesium is plunged into the solution. This would not be the case if the formation of a metallic couple were necessary for the evolution of the gas.

There is no cessation in the evolution of gas during the course of the reaction under any circumstances. The length of time necessary for the completion of the reaction in dilute solutions is undoubtedly due to the mechanical protection of the magnesium by the deposit, as Professor Tilden suggested.

***122. " Properties and relationships of dihydroxytartaric acid."**

By Henry J. Horstman Fenton, M.A.

Bearing in mind the highly interesting constitution of dihydroxytartaric acid, and the close relation which has been shown to exist between this acid and dihydroxymaleic acid, a further investigation of its properties appeared to be desirable, especially as the free acid appears to have been scarcely studied.

It is now found that the free acid may very easily be prepared in a pure state by oxidation of dihydroxymaleic acid in presence of water. The yield is over 70 per cent. of that demanded by theory. The dry acid shows no tendency to lose water at 90°. In aqueous solution, the acid decomposes when heated into tartronic acid and carbon dioxide. This reaction affords a very convenient method for the preparation of pure tartronic acid, the yield being 97 per cent. of that theoretically obtainable. On titration with alkalis at 0° dihydroxytartaric acid behaves normally as a dibasic acid. But the results obtained at the ordinary temperature with caustic alkalis, using phenolphthalein as indicator, are considerably higher, being intermediate between those required for a di- and a tri-basic acid. These high results are shown to be due to the partial decomposition of the salts formed into tartronates and carbon dioxide.

By careful treatment with certain reducing agents dihydroxytartaric acid may be reduced to dihydroxymaleic acid or its isomeride. Zinc, in calculated quantity, and dilute acid reduces it to the β -form. Hydro-

gen bromide reduces it to dihydroxymaleic acid (α -form) with liberation of free bromine.

The reaction $C_4H_4O_6 + 2H_2O + Br_2 = C_4H_6O_8 + 2HBr$ is in fact a reversible one, the final distribution depending upon the masses of the reacting substances and perhaps somewhat on the temperature.

***123. "The molecular association of liquids and its influence on the osmotic pressure." By Holland Crompton.**

In a paper which I recently had the honour of bringing before this Society (Trans., 1897, 71, 925), I contended that the molecular association of liquids exercises an influence on their osmotic pressure, and endeavoured to show how this influence may be taken into account. My attention has been drawn to the fact that Planck, more especially, has long since proved that association could have no effect on the osmotic pressure of liquids (see the discussion between Planck and Wiedemann, *Zeit. physik. Chem.*, 1888, 2, 241, 343). This being the case, I wish to offer the following brief criticism of Planck's results.

In his *Vorlesungen über Thermodynamik* (Leipzig, 1897), Planck deduces on p. 235 the following formula for the osmotic pressure of a dilute solution $P = \frac{R\theta}{n_0 m_0 v} (n_1 + n_2 + n_3 + \dots)$. Here R is the constant of the gas equation, θ the absolute temperature, $n_1 + n_2 + n_3 + \dots = n$ the number of dissolved molecules, n_0 the number of molecules of the solvent, m_0 its molecular weight, and v its specific volume (volume of unit weight). Since $n_0 m_0 v = V$ is practically the whole volume of the solution $P = R\theta n/V$. This is, of course, van't Hoff's equation for the osmotic pressure, and it is argued that the product $n_0 m_0 v$ being simply the total volume of the solution, the pressure is independent of any change produced by association in m_0 . In other words, as long as V is constant P will remain constant, no matter what the value of m_0 .

The nature and derivation of this relationship will perhaps be best understood if we suppose that we have two gases, and that n molecules of the first are dissolved in, or mixed with, n_0 molecules of the second. The partial pressure of the first gas in the mixture is $n/(n_0 + n)$ of the total pressure, or if n is small in comparison with n_0 , we may say n/n_0 of the pressure of the second gas. The pressure of this latter is RT/V_a , and in order that R may have a fixed value, let V_a be the molecular volume $m_0 v_0$ of the gas, where m_0 is its molecular weight, and v_0 its specific volume. The partial pressure of the dissolved gas then becomes $p = RTn/n_0 m_0 v_0$ or, since $n_0 m_0 v_0 = V_0$, the whole volume of the solvent gas, $p = RT/nV_0$.

These equations for the partial pressure of a gas present in a dilute state in any gaseous mixture are identical in form with those of Planck for the osmotic pressure of dilute solutions. It follows then that we have apparently only to liquefy the solvent gas, to substitute the molecular volume of the resulting liquid solvent for that of the gaseous solvent, and the partial pressure of the dissolved gas then becomes its osmotic pressure in the solution.

The result is not surprising, for it is obtained by a practical reversal of Planck's line of argument. It will be found (*loc. cit.*, p. 215) that, in his treatment of the thermodynamics of dilute solutions, he adopts the view that any such solution could be completely gasified without any change in the values of n and n_0 , and, of course, the osmotic pressure of the dissolved compound in the solution would then become the partial pressure of the dissolved gas in the gaseous mixture. But the view that a solution could be completely gasified without any change of a permanent character in the values of n and n_0 cannot be regarded as justifiable in the light of all the recent work on the molecular condition of liquids. And although it is not surprising to find that, starting with this view, Planck subsequently comes to the conclusion that association of the solvent does not influence the osmotic pressure of a solution, the reasoning evidently moves too completely in a circle to carry much conviction with it.

For, in order to ascertain what effect a change due to molecular association in the solvent would have on our formulæ, let us first take the case of the mixed gases, and suppose the gas we term the solvent to be one, say, like nitrogen dioxide, NO_2 , which undergoes association as the temperature falls. Such association will bring about a change of m_0 to αm_0 , of n_0 to n_0/α , and of v_0 to v_0/α , if α represents the degree of association (factor of association) for any temperature T . The partial pressure of the dissolved gas now becomes $p = \alpha RTn/n_0 m_0 v_0$, or since $n_0 m_0 v_0 = V_0$, $p = \alpha RTn/V_0$. Hence, although when a gas is dissolved in any other gas and is present only in a dilute condition, its partial pressure will, under normal conditions follow the law that $pV_0 = nRT$ if association of the solvent sets in, the law for perfect gases no longer holds, but the relationship becomes $pV_0 = \alpha nRT$ where α represents the factor of association of the solvent for the temperature T .

In fact, the partial pressure of the dissolved gas is, under the above conditions, dependent on the volume occupied by the solvent. Under normal conditions, the solvent obeys the usual gas equation, and the partial pressure therefore alters in accordance with this relationship. But if association or dissociation of the solvent sets in, the gas equation will not immediately apply, but will require a suitable modification, and this modification will hold also for the partial pressure formula.

Now the osmotic pressure of a dilute solution presents an analogous case. As long as the solvent is a monomolecular one we may accept Planck's reasoning and hold that the osmotic pressure follows the law $P = nR\theta/n_0m_0v$. But suppose that the solvent begins to undergo association, so that for any given temperature θ a change of m_0 to xm_0 has taken place. At the same time n_0 changes to n_0/x , and a simultaneous change will be found to have taken place in v . This last change has, it seems to me, been entirely overlooked up to the present, although any one who gives the matter a moment's consideration cannot fail to admit that an associated liquid would not have the density of the same compound in the monomolecular condition. All the evidence at present points to the conclusion that association increases the density of a liquid, and that consequently association would alter the value of v to v/a . The precise magnitude of a cannot at present be ascertained (unless perhaps with the aid of Traube's investigation of the molecular co-volume), but its value is probably not far removed from that of x . The osmotic pressure then of any dilute solution, the solvent of which is undergoing association, would be given by $P = anR\theta/n_0m_0v$, or since $n_0m_0v = V$, by $P = anR\theta/V$, an expression that is similar to the partial pressure formula. While, then, the osmotic pressure of any substance in solution in a monomolecular solvent follows the gas equation $PV = R\theta$, if the solvent is one which is undergoing association or dissociation, the equation for the osmotic pressure becomes $PV = aR\theta$.

And here another point which has apparently always been overlooked by those who contend that association of the solvent does not influence the osmotic pressure may be alluded to. It has been usual, hitherto, to compare with one another two stable systems, one of which is assumed to contain a monomolecular solvent and the other the same solvent in the associated condition and to show that the gas equation $PV = R\theta$ applies to each. The comparison, however, should not be between a monomolecular and an associated solvent, but between a monomolecular and an associating solvent, *i.e.*, one in which the association is continually altering with the temperature. The gas equation would hold for the gas NO_2 , and it would hold equally for the gas N_2O_4 , but it will not apply throughout the range of temperature in which $\text{N}_2\text{O}_4 \rightleftharpoons 2\text{NO}_2$. The gas equation might in like manner hold for the osmotic pressure of a substance in solution in water of the molecular weight 18, and it might also hold for water of the molecular weight 3×18 , but water, as we know it, is neither of these compounds. It is a substance the association of which is continually changing with the temperature and the attempt is therefore being made to apply the gas equation in the range of temperature throughout which $(\text{H}_2\text{O})_n \rightleftharpoons n\text{H}_2\text{O}$.

Van Laar has, like Planck, treated the osmotic pressure of dilute

solutions from the thermodynamical standpoint and confirmed the latter's conclusion that association of the solvent does not influence the osmotic pressure. I quote here literally what Van Laar says on this matter (*Zeit. physikal. Chem.*, 1895, 18, 274):—

"We found that the osmotic pressure $\pi = R\tau\sigma(1+a)/v_a$, where $\sigma(1+a)$ has the value Σc_2^* , and v_a the volume of one gram molecule of the pure solvent. For water v_a was therefore given the value 18. *If, however, association occurs, the weight of the gram molecule would be $18a$, so that for v_a the volume of $18a$ grams of water must be substituted. Calling this last V_a , then $V_a = av_a$. But also σ the concentration of the dissolved substance, becomes a times greater. For we have now no longer one molecule of the dissolved substance to n molecules of water (taking the mol. wt. of water = 18) but one molecule to n_1/a molecules of water, so that the concentration must be expressed by an a times greater number than before. Calling this C , then as $C = a\sigma$, the expression $\pi = R\tau C(1+a)/V_a$ does not differ from $\pi = R\tau\sigma(1+a)/v_a$, where the quantities v_a and σ are independent of the association."*

The italics in the above are mine, for it is to this portion of the paragraph that I wish to direct attention more especially. The molecular volume of any compound is given by M/d , where M is the molecular weight of the compound and d its density. Now Van Laar supposes that if liquid water had the molecular weight 18, its molecular volume would be $18/1$, or if it had the molecular weight $18a$, its molecular volume would be $18a/1$. In other words, the same density is to be assigned indiscriminately either to the monomolecular or to the associated compound. But can any one doubt if *liquid* water were obtainable having the molecular weight 18, that it would most certainly not have the density 1 at ordinary temperature? Take water merely as the first term of the $C_nH_{2n+1}OH$ series of alcohols, a series the members of which are themselves associated, but not to the same extent as water, and analogy at once points to a much lower density than 1 for *monomolecular* liquid water, a density that is in fact probably not far removed from $1/a$. In fact there is absolutely no evidence that the molecular volume of an associated liquid does differ greatly from that of the same liquid compound in the monomolecular state. Van Laar's argument *against* is converted therefore into an argument *for* the effect of association on the osmotic pressure.

* The c here is the n of the Planck formula.

RESEARCH FUND.

A meeting of the Research Fund Committee will be held in December. Applications for grants, accompanied by full particulars, should be sent to the Secretaries on or before December 11th.

KEKULÉ MEMORIAL LECTURE.

The Kekulé Memorial Lecture will be delivered by Professor F. R. Japp, LL.D., F.R.S., at an extra meeting of the Society on Wednesday, December 15th, at 8.30 p.m.

At the next meeting, on December 2nd, there will be a ballot for the election of Fellows and the following paper will be read.

"On Collie's space formula for benzene." By F. E. Matthews, Ph.D.

PROCEEDINGS
OF THE
CHEMICAL SOCIETY.
EDITED BY THE SECRETARIES.

No. 185.

Session 1897-8.

December 2nd, 1897. Professor Dewar, F.R.S., President, in the Chair.

Certificates were read for the first time in favour of Messrs. Charles Edward Brittain, B.Sc., 11, Highfield, Scarborough; William Arthur Caldecott, B.A., Box 1891, Johannesburg, S.A.R.; John Cooper, B.Sc., 20, Derwentwater Road, Gateshead; Frederick Cowling, Clay Cross, near Chesterfield; Wilbraham T. A. Edwards, Reduit, Mauritius; Frederick Gilderdale, 3, Havelock Street, Newcastle; William Setten Gilles, Coniston, Cedars Road, Beckenham; William Hobson Mills, B.A., Jesus College, Cambridge; Frank Forster Renwick, Glengall, Woodford Green, Essex; William Colebrook Reynolds, 64, Lydford Road, Paddington, W.; Andrew Jamieson Walker, B.A, Kilycadden, Killygordon, Co. Donegal; Ernest Charles Weismüller, 30, Pepys Road S., New Cross, S.E.

The following were duly elected Fellows of the Society:—John Ball, Ph.D.; William Ball; Alec. Alfred Beadle; Richard Oxley Burland, J.P.; Alexander McLean Cameron; Alexander Clarkson; Frank Collingridge, B.Sc.; James Murray Crofts, B.A.; John Daniell; Andrew James Dixon, F.I.C.; Oscar Guttmann, F.I.C.; Robert Hamilton; John Harger, B.Sc., Ph.D.; James Walter Horseman; Charles Kelly; Tom Lemmey, B.A.; James Scott Maclaurin, D.Sc.; Alan Macmullen, B.A.; Charles Jodrell Mansford, B.A.; Edward Masters; John A. Mathews, M.A., M.Sc.; Philip George Gregory Moon; James Charles Philip, B.Sc., Ph.D.; Alexander Ferguson Reid; Ernest Henry Roberts; Edward Sydney Simpson, B.E.; Robert Francis Wood Smith; Thomas Southern, Junr.; Frederick William Steel; Michael Edmund Stephens; George Stubbs; Edward Howard Tripp, Ph.D.; John Scriven Turner; Framjee Khurshedjee Viccajee; Percy John Vinter, M.A.; Arthur James While; Francis Samuel Young, M.A.

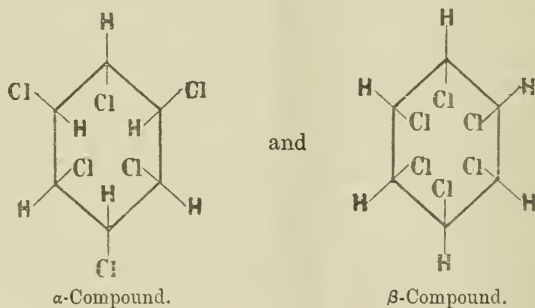
The PRESIDENT called the attention of Fellows to the fact that, although according to the Council regulations no paper could be announced which had not been received, it was open to any Fellow to make a communication at a meeting of the Society in the event of there being available time, provided that he handed a written statement to the Secretaries of the essence of his communication.

In answer to a question from Dr. HAKE, the PRESIDENT said that the appearance of such communications in the Proceedings would be subject to the editorial discretion of the Secretaries, and that when presented as full papers they would come before the Publication Committee in the usual way.

The following papers were read :—

***124. "The representation of the isomeric benzene hexachlorides by Collie's space-formula." By Francis Edward Matthews, Ph.D.**

This paper discusses Collie's space-formula for benzene from the point of view of the halogen hex-addition compounds. The formula is shown to explain the existence of two isomeric hexachlorides satisfactorily, and the following formulæ are proposed for these compounds :—



These formulæ likewise explain the differences in stability towards alcoholic alkalis. The α -substance, containing the chlorine in the ortho-position to, and on the same side of the carbon nucleus as the hydrogen-atoms with which it is removed in the form of hydrogen chloride, is readily decomposed; the β -substance, in which the hydrogen and chlorine are on opposite sides of the nucleus, has much greater stability. The remainder of the paper discusses the formation of benzene di-derivatives from mono-derivatives, and it is maintained that their formation is best explained by assuming the previous formation of unstable *ortho*-addition-compounds instead of unstable *meta*-compounds, as Collie has suggested.

DISCUSSION.

Dr. WYNNE asked whether any explanation could be given of the formation of 1 : 2 : 4-trichlorobenzene from the benzene hexachlorides by the action of alcoholic potash. The usually accepted formulæ for

benzene gave no clue to the reason for the production of unsymmetrical derivatives in such cases, and he was unable to see that the formulæ now proposed were more satisfactory in this respect.

Dr. LAPWORTH pointed out that the author's statement as to the impossibility of explaining the production of two different hexachlorides from benzene by means of any formula prior to Collie's, appeared to need qualification. It is easily seen that Kekulé's formula represents several stereoisomeric substances, as each "doubly bound" pair of carbon atoms may form a fumaroid or maleoid combination. Taking into consideration the circumstance that, for a number of reasons, the formula must be considered as a labile one, the positions of the ethylenic and single linkings being supposed to alternate, it is not impossible that, under the conditions of interaction of chlorine and benzene, the latter may react in the form of two or more of its possible stereoisomers. The addition of chlorine to a pair of carbon atoms double bound as in fumaroid compounds would, of course, afford a trans-dichloro-derivative, whilst a cis-dichloro-compound would result if the original combination were of the maleoid type. Kekulé's formula, therefore, would appear to afford a perfectly satisfactory explanation of the production of more than one benzene hexachloride.

Mr. E. J. PARRY asked if Dr. Matthews had any experimental evidence for assigning the symmetrical formula to the α -hexachloride, and the unsymmetrical to the β -compound. If the explanations of substitution offered by Collie and the author were correct, there should certainly be twice as much ortho- as para-dichlorobenzene produced when chlorobenzene is chlorinated. Further, he could not understand why, if these explanations were correct, the nitration of chlorobenzene should give ortho- and para-compounds whilst the chlorination of nitrobenzene, or the nitration of nitrobenzene, should yield meta-compounds.

Dr. MATTHEWS, in reply, stated that it had always seemed to him a remarkable fact that 1:2:4-trichlorobenzene alone was produced by the action of alkalis upon the benzene hexachlorides. He had made several attempts with large quantities of material to isolate the symmetrical modification, but always without result. The formation of the 1:2:4-compound could, however, be easily explained, either by Kekulé's or Collie's formula.

With regard to Dr. Lapworth's remarks, the formulæ proposed above account for the production of two and not of a greater number of isomerides which might be expected if these hexachlorides were regarded as cis- and trans-modifications; whilst certain properties of the compounds do not seem to harmonise with the idea that they are stereoisomerides.

The answer to Mr. Parry's questions are contained in the paper itself, the difference in stability of the two hexachlorides towards alkalis is explained by assuming that hydrogen chloride is more readily removed from atoms in the ortho-position and on the same side

of the carbon nucleus than from those in which these conditions do not obtain. Hence the above formulæ were assigned.

***125. "Compounds of piperidine with phenols." By Otto Rosenheim, Ph.D., and Philip Schidrowitz, Ph.D.**

With a view of obtaining substances of the general formula $(C_6H_{(6-n)})(C_5H_{10}N)_n$, which seemed to be of interest on account of their relation to the phenylenediamines and polyamines, the authors studied the action of piperidine on phenols and their derivatives in the presence of dehydrating agents. Although so far unsuccessful in this direction, a series of addition products in the nature of salts was observed, in which piperidine acts as the base, and the phenol as the acid. They are well crystallised compounds, easily obtained by the interaction of their components, usually in ethereal solution. They are resolved into their constituents by strong acid or alkalis. M. Oechsner de Coninck (*C. R.*, 1897, 124, 563) describes a number of colour reactions obtained by the action of piperidine and other bases on phenols in dilute aqueous solution, but has apparently not observed the formation of the addition compounds described in the paper.

The influence of the number and position of the oxy- and nitro-groups in the phenols on the additive capacity of the piperidine molecule was studied, but no general rule could be deduced.

The following compounds were analysed, and are described in the paper: Compounds of piperidine (1 mol.) with pyrocatechol (2 mols.), guaiacol (2 mols.), hydroquinone (1 mol.), pyrogallol (1 mol.), vanillin (1 mol.), *o*- and *p*-nitrophenol (1 mol.), picric acid (1 mol.), 1:2:4-dinitronaphthol (1 mol.). Phenol, *p*-chlorphenol, resorcinol, phloroglucinol, *m*-nitrophenol, and α - and β -naphthol did not furnish crystalline compounds.

KEKULÉ MEMORIAL LECTURE.

The Kekulé Memorial Lecture will be delivered by Professor F. R. Japp, LL.D., F.R.S., at an extra meeting of the Society on Wednesday, December 15th, at 8.30 p.m.

At the next meeting, on December 16th, the following papers will be read. The authors of those marked with an asterisk have announced their intention of being present.

* "Stereochemistry of unsaturated compounds. Part I. Esterification of substituted acrylic acids." By J. J. Sudborough, Ph.D., D.Sc., and Lorenzo L. Lloyd.

* "Formation and hydrolysis of esters." By J. J. Sudborough, Ph.D., D.Sc., and Martin E. Feilmann, B.Sc.

* "A new method of determining freezing points in very dilute solution." By M. Wilderman, Ph.D.

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No. 186.

Session 1897-8.

December 15th, 1897. Extra Meeting. Professor Dewar, F.R.S., President, in the Chair.

Professor F. R. JAPP, LL.D., F.R.S., delivered the Kekulé Memorial Lecture.

Friedrich August Kekulé was born at Darmstadt on September 7th, 1829. Originally intended for the profession of an architect, he was induced, by hearing Liebig's lectures, to devote himself to chemistry. After studying under Liebig, he spent a year in Paris, where he became intimate with Gerhardt. Later on, he resided for a time in London, making the acquaintance of Williamson and Odling. He always acknowledged the influence which these three chemists had exercised on the formation of his opinions. Kekulé's theories are based on Gerhardt's type theory; on Williamson's theory of polyvalent radicles, which, by their power of linking together other radicles, render possible the existence of multiple types; and on Odling's theory of mixed types, which was a deduction from Williamson's theory. Less consciously, perhaps, his opinions were influenced by E. Frankland's theory of the valency of elementary atoms, and by Kolbe's speculations on the constitution of organic compounds. Kekulé gathered together the various ideas which he found scattered throughout the writings of his predecessors, added to them, and welded the whole into the consistent system which forms our present theory of chemical structure. In 1857, in the course of a memoir on the constitution of fulminic acid, he gave a tabular arrangement of compounds formulated on the type of marsh gas, this being the earliest statement, although put forward only in an imperfect form, of the tetravalency

of carbon. In the same year, he published an important theoretical paper: "On the so-called Conjugated Compounds and the Theory of Polyatomic Radicles," which contains a complete system of multiple types and mixed types. In 1858, the celebrated paper, "On the Constitution and Metamorphoses of Chemical Compounds, and on the Chemical Nature of Carbon," appeared; it embodies the fully developed doctrine of the tetravalency of carbon, together with Kekulé's views on the linking of atoms and on the valency of such chains of atoms—the foundation on which our modern system of constitutional formulæ rests. In 1865, Kekulé put forward his well-known benzene theory—the crowning achievement, in his hands, of the doctrine of the linking of atoms, and the most brilliant piece of scientific prediction to be found in the whole range of organic chemistry. The conception of closed chains, or cycloids, which he thus introduced has shown itself to be capable of boundless expansion.

Kekulé published the first instalment of his *Lehrbuch der organischen Chemie* in 1859. The work was never finished; but it was instrumental in widely disseminating Kekulé's views and exercised enormous influence on the development of the science.

Kekulé obtained the *venia legendi* in Chemistry at the University of Heidelberg in 1856. Two years later he was called, as ordinary professor, to the University of Ghent, where he remained until 1867, when he was appointed to the Professorship of Chemistry in the University of Bonn, a post which he continued to hold until his death on July 13th, 1896. During his later years he suffered from bad health.

The characteristic note of Kekulé's great theoretical creation, the chemistry of structure, is the treatment of the problem of isomerism—the problem which first necessitated the use of constitutional formulæ—as one of geometrical symmetry. Kekulé's formulæ, freed from the fetters of the type theory with which he at first encumbered them, were merely more or less symmetrical geometrical figures. In order to predict the number of substitution compounds, it was only necessary to consider the degree of dissymmetry of the parent compound: the less the symmetry, the greater the number of isomeric substitution compounds. The extraordinary fertility of this conception is shown by the development which it has undergone at the hands of van't Hoff, J. Wislicenus, von Baeyer, and others.

The accuracy of Kekulé's predictions has done more to inspire a belief in the utility of legitimate hypotheses in chemistry, and has therefore done more for the deductive side of the science than that of almost any other investigator. His work stands pre-eminent as an example of the power of ideas. A benzene formula, consisting of a few chemical symbols jotted down on paper and joined together by lines, has supplied work and inspiration for scientific organic chemists

during an entire generation, and affords guidance to the most complex industry the world has yet seen.

Dr. HUGO MÜLLER, as probably the oldest personal friend of Kekulé present, moved a cordial vote of thanks to Professor Japp for his eloquent lecture, and added his special appreciation of the admirable and exhaustive manner in which the lecturer had accomplished his task. A considerable effort was needed to realise the condition in which organic chemistry stood fifty years ago, in order to recognise the vast advances which have been made in the interval. It may be truly claimed for Kekulé that he holds a foremost position amongst those reformers who have initiated this progress. It was here, in London, that Kekulé first conceived the ideas which, in their further development, assumed the shape of his "chemistry of carbon" and "benzene theory," and being in those days in almost daily intercourse with him, he well recollected the eagerness and enthusiasm with which the problems which occupied his mind were discussed.

Soon afterwards, in Heidelberg, and then in Ghent, his affable manner and sociability attracted a number of devoted pupils, who became active fellow-workers, and thus his teaching bore fruit in all directions.

Unfortunately, not long after he had been settled in Bonn, his health gradually gave way, and he suffered much from nervous prostration and an irksome degree of deafness, which at times much depressed him. His power of work became greatly impaired, and notwithstanding repeated heroic efforts, even his Handbook had to remain unfinished.

Professor THORPE, in seconding the resolution, also desired to give expression to the sense of obligation which the Society was under to Professor Japp for the thoughtful and eminently impartial address which he had given. There was, however, one slight but characteristic omission in the lecture. In enumerating Kekulé's students, Dr. Japp had neglected to make any reference to himself. It was, no doubt, that same feeling of piety to which he had borne witness in the course of his lecture on the part of another which induced Dr. Japp to comply so readily as he had done with the request of the Council that he should undertake the weighty and responsible duty of delivering this address. His personal intercourse, as a student, with the master had, we may take it, quickened his appreciation of his work. At the same time, as would be evident, it had in no sense diminished his critical faculty. The audience had recognised that the lecture was a truthful and well-balanced account, written impartially and in the true spirit of history, of the origin and fruit, so far as this had been gathered, of the great chemist's labours.

Some reference had been made to the fact that he (the speaker) had enjoyed the good fortune of also being a student under Kekulé, and of being associated with him, in some small degree, in certain experimental work which he undertook during the first years of his professorship in the magnificent institution which Germany owes to Hofmann. It is a curious coincidence that Hofmann, like Kekulé, might have become an architect, if destiny, as in Kekulé's case, had not intended that he should be a chemist. During the late sixties there was no sign of the decay in intellectual vigour which a few years later became so sadly obvious. At that time, the great generalisation which we associate with Kekulé's name was still, to some extent, on its trial, and it had to withstand the assaults which were from time to time delivered by keen and active opponents in other schools of chemical thought. It happened that very shortly after the speaker's entrance into Kekulé's laboratory, he was called upon to handle the weapons which Kekulé himself placed in his hands in order to defend a small, but apparently vulnerable point, in the theory. That circumstance proved of incalculable benefit to him, in that it brought him into intimate personal contact with Kekulé, and enabled him to see something of his methods of work, and of the springs of his intellectual activity. Dr. Japp has ably testified to Kekulé's merits as a teacher. Kekulé, indeed, was one of the very best expositors, with the single possible exception of Kirchhoff, to whom it had been the speaker's lot to listen. As a laboratory teacher he was excellent. He was a most severe judge of work, striving to exact the same high manipulative finish, the same neatness and order, which he invariably bestowed on everything he did, and he was absolutely intolerant of anything slovenly or 'sloppy.' But it was as a lecturer that he was seen at his best. He was singularly luminous as a thinker, a close and accurate reasoner, with a remarkable power of concentrated expression. He was not a rapid speaker, and he never indulged in those rhetorical flights with which Hofmann occasionally was wont to electrify an audience. His language was apt and well chosen, and his delivery easy and natural. His lecture-table was never overburdened with 'experiments'; those he showed were strictly proper to the subject in hand. To see him handle the chalk was in itself a liberal education. Although everything appeared to be so easy and natural, an attentive critic could hardly fail to perceive that the lecture had been carefully thought out beforehand, possibly over a longer period of time than it took to utter. Every detail would seem to have been considered, even to the particular places on the black-board where the formulæ should appear.

During the later period of his life, Kekulé, unfortunately for Science, was comparatively sterile. Those who knew him, however, would be the first to affirm that this seeming apathy sprung from no natural

indolence. There is no doubt that he suffered, even in the early period of middle life, from the intense stress and strain of his mental labours prior to the Ghent period. He had too surely exemplified the sad truth of Liebig's saying, to which Dr. Japp had referred, that he who would become a great chemist must pay for his preeminence by the sacrifice of his health. There is reason to know that it was the consciousness of failing power which prevented him from finishing much to which he had put his hand, and that his fastidiousness and his sense of "finish," amounting almost to hypercriticism, restrained him from publishing what he realised fell short of his ideal. What he has left us, however, is an imperishable monument to his genius.

The PRESIDENT said that there was little to add to Professor Japp's exhaustive eulogy of the life and work of Kekulé. His own early relations, however, with the great chemist whose life work the Society was commemorating might have some interest to the members and ought to be told. While a student with Lord Playfair at Edinburgh, in the session 1866—67, he made his first contribution to Science in the shape of a little paper entitled, "On the Oxidation of Phenyl Alcohol and a Mechanical Arrangement adapted to Illustrate Structure in the Non-saturated Hydrocarbons." This note appeared in the *Proceedings of the Royal Society of Edinburgh*, and he was so desirous of becoming known to Kekulé as a student of his theory of the aromatic bodies that a specimen model was sent to Ghent. Lord Playfair addressed a letter to Kekulé stating that he (Professor Dewar) was very anxious to work in his laboratory. The reply was "Come," and the reception and kindness he received from Kekulé has always had his profound gratitude.

The summer of 1867 was thus spent in the private laboratory of Kekulé. Before leaving Edinburgh, he had been working on the coal tar bases, and a supply was taken with him to Ghent. There he began the study of the oxidation products of picoline, and at the British Association Meeting at Norwich, in 1868, an account of the separation of dicarbopyridinic acid, the analogue of phthalic acid in the benzene series, was given. At the same meeting, he gave a paper on "Kekulé's Model to Illustrate Graphic Formulæ." This is the succinct history of the beginning of the pyridine-benzene analogy. His old friend, Koerner, had speculated in the same direction, and he (Prof. Dewar) might confess that in his opinion they both had received too much credit for an extension of the benzene theory to pyridine. At a distance of thirty years, to look back and call to mind the presence and personality of the great chemist as he knew him was indeed a pleasure. He was a man of noble mien, handsome, dignified, and yet of a homely and kindly disposition. He was a severe critic, having a haughty contempt for the

accidental and *bizarre* in scientific work. His originality and suggestiveness seemed endless, so that he had no need to commit scientific trespass or to follow just in the wake of other people's ideas. Everything that passed through the Kekulé alembic was indeed transmuted into pure gold. His precision of thought and diction rendered his papers profoundly suggestive to other workers. His great work will always live in the history of our Science, and his loving memory will be for ever enshrined in the hearts of his pupils.

December 16th, 1897. Professor Dewar, F.R.S., President, in the Chair.

Messrs. James C. Philip, Edward Rosling and Frank T. Addyman were formally admitted Fellows of the Society.

The PRESIDENT announced that the following had been recommended by Council for election as Foreign Members, to be balloted for at the next meeting, January 20th, 1898.

Prof. Remsen, Baltimore, U.S.A.; Prof. Troost, Paris; Prof. Moissan, Paris; Prof. Raoult, Grenoble; Prof. Ostwald, Leipzig; Prof. Curtius, Bonn; Prof. Mensutkin, St. Petersburg; Prof. Markownikow, St. Petersburg; Prof. Arrhenius, Stockholm; Prof. Waage, Christiania; Prof. Franchimont, Leyden; Prof. van der Waals, Amsterdam; Prof. Spring, Liège; Prof. Körner, Milan.

Certificates were read for the first time in favour of Messrs E. L. Allhusen, B.Sc., Geological Survey, Perth, W.A.; B. S. Bull, M.A., B.Sc., Ph.D., 49 Devonshire Road, Greenwich; T. H. Hills, 6 Eliot Park, Blackheath; J. E. Miller, Holmoor, Patrington, Hull; G. T. Morgan, 35A Russell Road, Kensington, W.; W. E. Moss, B.A., Burnthwaite, Bolton; H. Poole, 323, W. 34th Street, New York; W. Richards, Old Elvet, Durham.

The following papers were read :—

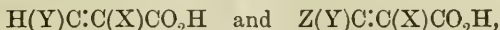
*126. "Stereochemistry of unsaturated compounds. Part I. Esterification of substituted acrylic acids." By John J. Sudborough and Lorenzo L. Lloyd.

In order to determine whether there is any general rule applying to the esterification of unsaturated acids, similar to those discovered by Mensutkin for fatty acids, and by Victor Meyer and Sudborough for aromatic acids, the authors have investigated the following acids: cinnamic acid, allocinnamic acid, atropic acid, ortho-, meta-, and para-nitrocinnamic acids, α -bromocinnamic acid, α -bromallocinnamic acid, two β -bromocinnamic acids, two α - β -dibromocinnamic acids, α - β -dichlorocinnamic acid, α - β -diiodocinnamic acid, α -cyanocinnamic acid, α -cyano-meta- and α -cyano-ortho-nitrocinnamic acid, α -phenylcinnamic

acid, α -phenylallocinnamic acid, six α -phenylnitrocinnamic acids, triphenylacrylic acid, α - β -di-iodoacrylic acid. Half a gram of each acid was boiled for an hour with 10 c.c. of a 3 per cent. solution of hydrogen chloride in methylic alcohol, and the amount of ester formed determined in the usual manner.

The authors draw the following conclusions from the results which they have obtained :—

(1) Unsaturated acids of the types,



yield but small amounts of ester when treated in the manner described.

This furnishes a ready method for distinguishing stereoisomeric acids. (1) $\text{H(Y)C:C(X)CO}_2\text{H}$ and (2) $\text{H(Y)C:C(CO}_2\text{H)X}$.

As acids of the *trans*-type (1) are esterified with difficulty, and acids of the *cis*-type (2) with ease by the above method, it is probable that the method can also be used for separating mixtures of such acids, in very much the same manner that diortho-substituted benzoic acids can be separated from their isomers.

(2) An α -substituted acrylic acid, $\text{CO}_2\text{HC(X):CH}_2$, is more difficult to esterify than a β -substituted acid, $\text{CO}_2\text{HC(H):CHX}$.

(3) In certain substituted cinnamic acids, a nitro-group in the ortho-position appears to have a retarding influence. The results obtained are completely in accord with those published by Anschütz (*Ber.*, 1897, 30, 2652) whilst the present work was still being carried out.

The constitution of camphoric acid is discussed in the light of the results contained in the paper.

The authors think it desirable to carry out similar researches with substituted acids; they have already found that dibromosuccinic acid, phenyldibromopropionic acid and its nitro-derivatives, yield but little ester when boiled for an hour with a 3 per cent. solution of hydrogen chloride in methylic alcohol. Several new methylic esters have been obtained, and are described in the paper.

*127. "Formation and hydrolysis of esters." By John J. Sudborough, Ph.D., D.Sc., and Martin E. Feilmann, B.Sc.

From the researches of Mensutkin (*Annalen*, 1879, 195, 334, 1879, 197, 193) on the esterification of fatty acids, of Victor Meyer and Sudborough (*Ber.*, 1894, 27, 510, 1580, 3146) on substituted benzoic acids, and of Sudborough and Lloyd (preceding abstract) and Anschütz (*Ber.*, 1897, 30, 2652) on unsaturated acids, the authors consider it proved beyond doubt that stereochemical influences play a most important part in the esterification of an acid by means of an alcohol and hydrogen chloride. Researches by Kellas (*Z. physik. Chem.*, 1897,

25, 221) on the esterification of monosubstituted benzoic acids, and of Sell (Trans., 1897, 71, 1070) on substituted pyridinecarboxylic acids also support the same conclusion. In the benzoic and acrylic acid series, the chemical nature of the substituting groups has but little, if any, influence on the retardation of esterification. CH_3 , F, Cl, Br, I, NO_2 , OH and CO_2H groups all act in the same manner; the radicle weight or volume, however, affects the retardation to a certain extent (Meyer, *Ber.*, 1895, 28, 1259, and Kellas, *loc. cit.*).

One would therefore conclude that in the fatty series, too, the chemical nature of the substituting groups would have but little, if any, apparent influence. A tertiary fatty acid, however, such as trimethylacetic acid, yields but little ester when heated with alcohol (Mensutkin), whilst the similarly constituted trichloroacetic acid is most readily esterified, in fact, much more readily than acetic, mono- or di-chloroacetic acids (Lichty, *Am. Chem. J.*, 1896, 18, 590). This difference in behaviour we can only attribute to the enormous increase in strength of the acid.

	K		K
(1) Acetic acid	0.0018	(3) Dichloroacetic acid	5.14
(2) Chloroacetic acid	0.155	(4) Trichloroacetic acid	121.0

Lichty's researches show that these four acids follow exactly the order given above as regards the ease with which they are esterified. The amounts of ester formed at the end of any given time by no means bear the same ratio to one another as do the affinity constants of the corresponding acids.

	After 1 min.	1 hour.	2 hours.
Chloroacetic	1.78	41.89	57.33 per cent.
Dichloroacetic ...	4.56	56.49	62.34 „
Trichloroacetic ...	9.99	59.39	66.18 „

It would appear then that some other factor is introduced which tends to hinder the formation of the esters, and this factor the authors consider to be the stereochemical influence of the chlorine atoms. The general conclusion drawn is that in the conversion of an acid into its ester by the action of an alcohol, either with or without hydrogen chloride, the rate of esterification is determined by two factors:—1. The configuration of the acid, in other words, the presence of substituting groups situated close to the carboxylic group, which always tend to hinder esterification. 2. The strength of the acid as determined by its affinity constant. In most of the cases which have been more closely studied, the first factor is the more prominent, and obscures, to a large extent, the influence of the second factor. In exceptional cases, however, namely, in acids the strength of which has been enormously increased, the second factor becomes the more prominent, and the influence of con-

figuration is cloaked. In all cases, however, we must suppose the two factors to be in force, and it is only in acids which have the same affinity constant that the true effect of stereochemical influence can be looked for.

No general systematic study of the rate of hydrolysis of esters appears to have been attempted. Victor Meyer (*Ber.*, 1895, 28, 1263) formulated the generalisation that those esters which are the most difficult to form are also the most difficult to hydrolyse. This view was also held by Wegscheider (*Ber.*, 1895, 28, 2536) and Brühl, but according to the more recent investigations of Kellas, this generalisation is not strictly correct. Kellas (*loc. cit.*) studied the rate of hydrolysis of the methyl salts of monosubstituted benzoic acids by means of alkali. He found that in any given series the ortho-compound is always the most difficult to hydrolyse, the para- occupies an intermediate position, and the meta- is most readily hydrolysed (with the exception of the nitro-compounds). It is stated, however, that methylic orthonitrobenzoate is much more readily hydrolysed than methylic orthotoluate, although the nitro-ester is formed much more slowly than the toluate. This and similar results noted by Kellas, for example, the fact that methylic benzoate is difficult to hydrolyse, can be accounted for by the introduction of the affinity of the acid as a factor. For orthonitrobenzoic acid $K=0.616$, for orthotoluic acid $K=0.012$, and for benzoic acid $K=0.006$. The results obtained by Hjelt (*Ber.*, 1896, 29, 1864) on the hydrolysis of the ethylic salt of substituted malonic acids also lead to the same conclusion. They indicate that here, also, the rate of hydrolysis does not depend merely on the stereochemistry of the ester molecule. If the affinity constants are taken into consideration, the obstruction due to the substituting groups is much more pronounced (with the exception of ethylic allylmalonate). Investigations by the authors on the hydrolysis of the ethylic salts of acetic, methyl-, dimethyl-, and trimethylacetic acids by the aid of sodium hydroxide, prove that here, where the affinity constants of the acids vary but little—acetic acid $K=0.0018$; propionic acid $K=0.00134$; isobutyric acid $=0.00144$, and trimethylic acetic acid (unknown, but at any rate very small, since the salts of this acid are extremely unstable),—the rates of hydrolysis are what would be expected from the introduction of the substituting groups—

	Hours.	0.25	0.5	1	1.5	2.5	3	4	4½	8	10	22.5	70	
Ethylic acetate.....	19.6	28	42				66			82.6	85.4			per cent.
„ propionate.....	14.4	19.6		35.6			50.8	61.2						„ „
„ isobutyrate.....	5.2	7.2	11.4		19.2							61		„ „
„ trimethylacetate				2.4				6.8		8.8		19.6		„ „

With the esters of chlorinated and brominated acetic acids, the reverse is true, and all are decomposed much more readily than ethylic acetate

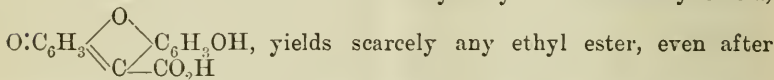
itself. Comparative experiments with these esters are being undertaken by the authors.

The general conclusion arrived at is, therefore, that in the hydrolysis of esters by the aid of an alkali, the same two factors operate as in esterification. The strength of the acid which is formed by the hydrolysis of the ester seems, however, to play a more important part than it did in esterification, and this accounts for the fact that it does not always follow that esters which are most readily formed are the most readily hydrolysed.

Other factors are apparently introduced when esters are hydrolysed by the aid of hydrochloric acid, as it has been proved that esters by no means arrange themselves in the same order when hydrolysed by an alkali as when hydrolysed by an acid (Hemptinne, *Z. physik. Chem.*, 1894, 13, 561; Löwenherz, *ibid.*, 1894, 15, 389; Van Dyken, *Rec. Trav. Chim.*, 1895, 14, 106). The authors consider that these generalisations can be proved or refuted only by a much more careful study of the hydrolysis of numerous series of esters. They themselves intend investigating the ethylic salts of substituted (alkylated) succinic acids, as the strengths of these acids differ but little, and therefore the results obtained should throw light upon the retarding effect of different alkylic groups.

DISCUSSION.

Dr. HEWITT said that the fact that hydroxylfluoronecarboxylic acid,



prolonged boiling with 9 parts by weight of ethyl alcohol and 1 part of concentrated sulphuric acid, is easily explicable in the light of Dr. Sudborough's work. Hydroxylfluoronecarboxylic acid is a tri-substituted acrylic acid, and hence should not easily esterify. On the other hand, Victor Meyer showed that triphenylacrylic acid, $\text{Ph}_2\text{C}:\text{C}(\text{Ph})\cdot\text{CO}_2\text{H}$, yielded an ester by prolonged boiling with methyl alcohol and a stream of hydrogen chloride. Under similar circumstances, triphenylacetic acid, $(\text{C}_6\text{H}_5)_3\text{CO}_2\text{H}$, furnished very little ester.

Dr. SHIELDS called attention to the numbers, quoted by the authors of the papers, representing the percentage amount of etherification after one minute, one hour, and two hours, and remarked that, whereas all the limiting values were approximately the same after sufficient time had elapsed, a considerable difference existed between the numbers when the amount of transformation was measured after the lapse of only one minute. If it had been possible to obtain the corresponding values after one second, he thought the difference would have been

still greater, and that in any serious attempt to study parallelism between the velocity of etherification and the affinity constants of the acids, it would be necessary to determine the velocity constant of the reaction or the initial rate of etherification.

***128. "A new method of determining freezing points in very dilute solution." By Meyer Wilderman, Ph.D.**

The chief condition for obtaining correct determinations of the freezing point is the establishment of equilibrium between the solid and the liquid part of the heterogeneous system. Starting from the properties of "perfect" equilibrium, and from the equations for velocity of ice-melting, ice-separation, and Newton's equation for cooling, all the conditions necessary for a successful experiment, previously laid down empirically by the late P. B. Lewis and then by the author, are now deduced from theoretical considerations. It is shown how to arrange the equilibrium with an accuracy of $0.00002-0.00006^\circ$ and even greater. The freezing point method, which has been hitherto a conglomeration of empirical rules, is thus placed on a physico-mathematical basis, and the experimental error of all previous methods can be calculated. The second important point in a freezing point method is a correct and very detailed knowledge of the registering instrument. A very careful study of the errors of mercury thermometers has been made for a long time, and an account of this is given. This paper is a continuation of that by P. B. Lewis (Trans., 1895, 67, 1).

DISCUSSION.

Mr. PICKERING expressed his disappointment that the author had not made any statement as to what his "new method" was. All that he had given was a summary, in the form of an equation, of the various inaccuracies inherent in freezing point determinations generally. These inaccuracies were well-known, and it was of great importance that they should be reduced to a minimum; but it was impossible to say whether the author's new method succeeded in doing this or not until a description of the method was given.

Dr. SHIELDS remarked that the literature and controversies on the vexed question of the accurate determination of the freezing point of dilute solutions would already fill a large volume. Since the subject was one of great importance in connection with the modern theory of solutions, any new contribution which was likely to lead to a final settlement of the conflicting views was welcome. He regretted that want of time had prevented Dr. Wilderman from giving a fuller account of his paper, but the method of attack adopted by the author

was undoubtedly a step in the right direction, and he thought that the study of the time reaction and of equilibrium in freezing solutions would lead, if it had not already in Dr. Wilderman's hands, led, to important advances.

Dr. WILDERMAN, in reply, stated that methods were given in the paper for obtaining the separated ice in fine films throughout the liquid. In answer to Mr. Pickering, he said that the value of the equations he laid down was that by them the errors due to equilibrium in the methods of other investigators could be estimated, and their results recalculated. As an illustration, one of the most accurate of the recent methods was recalculated, and its error found to be 160 times greater than his own. He had presented, for the first time, the physico-mathematical theory of freezing point determinations in such a form that future experimenters could arrange with ease the equilibrium to any degree of accuracy required.

***129. "A possible basis of generalisation of isomeric changes in organic compounds." By Arthur Lapworth, D.Sc.**

In this paper, the author points out that many isomeric changes, hitherto regarded as belonging to different types, may be formulated as special cases of a general form, which may be expressed by the reversible equation $R_a M \cdot R_\beta \cdot R_\gamma \rightleftharpoons R_a \cdot R_\beta \cdot R_\gamma M$, representing a labile group moving from an α -atom to a γ -atom, the necessary rearrangement of single and double bindings taking place between the three atoms R_a , R_β and R_γ . A conventional "mechanical" representation of the change is given for the special case where R_a , R_β and R_γ are carbon atoms.

Examples, for the most part derived from "tautomeric" and "desmotropic" substances, such as acetoacetic ether, cyanic acid, nitroso-compounds, &c., are shown to be of the above type.

Extensions of the above special form are deduced, and the general conclusion is arrived at, that in a chain of alternately singly and doubly-linked atoms, either (1) a labile group may become successively attached to alternate atoms, or (2) an exchange of labile groups in γ - (*i.e.*, meta) positions may occur. These deductions are shown to be confirmed by the behaviour of benzenoid compounds, &c., the fully justifiable assumption being made that benzenoid compounds may act as if possessing Kekulé's formula. Special reference is made to nitrophenol, orthohydroxyazobenzene, the sulphonic derivatives of aniline and of β -naphthol, and also to the changes of methylaniline into paratoluidine and of hydrazobenzene into benzidine, which are all shown to exhibit changes in complete accordance with the author's views.

Further modification of the general formula for the case where R_β and R_γ are singly, instead of doubly, linked, is shown to lead to the form $R_a \cdot M \cdot R_\beta \cdot R_\gamma \rightleftharpoons R_a \cdot R_\beta + R_\gamma \cdot M$, which represents on the one hand the great majority of simple molecular decompositions of organic compounds, and on the other the formation of the ordinary addition products from unsaturated substances. The production of substitution derivatives, &c., by successive addition and isomeric change (compare Armstrong, *Trans.*, 1887, 51, 258), as well as some simple cases of hydrolysis, are then discussed.

From the last formula, the following type is shown to be at once derivable: $R_a \cdot M + R_\beta \cdot R_\gamma \rightleftharpoons R_a \cdot R_\beta + R_\gamma \cdot M$, which represents the ordinary process of substitution in saturated compounds [compare Armstrong, *loc. cit.*, and Williamson ("Theory of Etherification," 1851)].

With the help of the foregoing principles, the author shows that the production of meta-di-derivatives from certain mono-derivatives of benzene may be consistently explained on the basis of Armstrong's suggestion (*loc. cit.*) that in such mono-derivatives addition of the acting agent to the side group precedes substitution. Further, this assumption at once explains the replacement (by a substituting group) of side groups, which otherwise afford meta-derivatives.

Some apparent exceptions to the foregoing principle are next dealt with, and it is shown that little difficulty exists in relegating to the above type the production of, for example, pinacolines from pinacones, acetanilide from acetophenone-oxime, benzoic acid from benzil, &c., on suppositions which, for the most part, the author has not been the first to make, and which mostly involve the intermediate production of ring-compounds.

It is further shown that the following type of change is possibly, but by no means necessarily, independent of the above, viz., $R_a \cdot M \cdot R_\beta \rightleftharpoons R_a \cdot R_\beta \cdot M$ (where R_β represents an atom possessing a "residual affinity" of two units), and a possible method of harmonising this with the other type is discussed in detail.

Finally, it is pointed out that, although a brief dissociation between the labile group and its attached atom must be assumed in order to account for the above changes, cases involving electrolytic dissociation or partial destruction of the labile substance necessarily involve probable changes other than an $\alpha\gamma$ -isomeric change, and should therefore be as far as possible avoided in investigating the applicability of the foregoing generalisation.

DISCUSSION.

Dr. WYNNE regretted that the author, in reading his paper, had thought it more important to enumerate the various well-known

cases of tautomerism, than to give the explanation he had devised to account for this property. So far as could be gathered, the author sought to connect those reactions in which a single radicle is transferred from one to the other of positions relatively 1:3 accompanied by a change of structure in the chain, with those in which mutual exchange of radicles in positions relatively 1:3 is brought about without any structural rearrangement. It was difficult to see wherein the analogy lay, but even if the author's contention were adopted, it was open to question whether anything had been thereby gained. The usual statement that ortho-, or para-, or both di-derivatives result from compounds of the phenylsulphamic acid type expressed the facts at least as clearly as the author's emendation, wherein the reaction is represented as being brought about by the radicle moving from any given position to the next but one. What was to be desired was an explanation of the cause of the mutual transference, not a re-statement of the fact of its occurrence.

The author's view of the formation of metanitrobenzene-sulphonic acid surely needed more explanation than the reaction for which it was put forward to account, and the same might be said of the arguments brought forward to explain the production of metasulphonic acids from aniline derivatives. A striking case of the production of such acids is exhibited by dimethylaniline, which with ordinary sulphuric acid gives the para-, whilst with fuming sulphuric acid, a mixture of the meta- and para-sulphonic acids is obtained. Yet, according to the author's views, the meta-sulphonic acid should be the sole product in either case, since he considers that compounds of the phenylsulphamic acid type—which dimethylaniline cannot form—give rise to parasulphonic, and compounds of the aniline hydrogen sulphate type—which dimethylaniline can form—give rise to metasulphonic acids.

Again, the order in which isomeric sulphonic acids seem to be formed in the case of β -naphthol had been adduced by the author in support of his views, but it was not difficult to quote cases in which it appeared to be inapplicable. Erdmann had shown that 1:4-, 1:4'-, and 1:3'- α -naphthylaminesulphonic acids are the products of the sulphonation of α -naphthylamine, and it was not easy to see how the production of the last named and most stable of these acids could be accounted for by the author, even if his views did not beg the question of the mode in which isomeric sulphonic acids are formed, as reference to Erdmann's paper would show.

He was, moreover, unable to follow the author in tracing an analogy between the changes involving the production of ethylene from ethyl bromide, and of ethyl bromide from ethylene on the one hand, and those occurring in tautomeric compounds on the other; an analogy, that is, between reactions involving scission of the chain, and those in

which none occurs. Markownikow's rule embraced what is known of such reactions, and the author's re-statement of some of the facts did not seem to add to, or explain, that well known summary.

Professor COLLIE said that this generalisation of Dr. Lapworth's appeared to him to be one of great importance. Any simple rule that would explain not only all cases of isomeric change amongst paraffinoid as well as amongst benzenoid derivatives, but also the hydrolysis of esters, the decomposition of diazo-compounds, the formation of meta-derivatives, &c., &c., was one which certainly claimed the attention of chemists. Moreover, it received much support from a stereochemical point of view; and if Dr. Lapworth's first equation be allowed, then the rest of the argument was a clearly worked out, logical deduction.

Dr. KIPPING agreed with the last speaker, that the paper under discussion was one of great interest and importance. Starting from a simple case of tautomeric change, by an ingenious and logical application of views already widely accepted, Dr. Lapworth had attempted to account for, and to bring into line, a very large number of cases of isomeric change, which before seemed to be complex, obscure, and not related to one another in any way. If this generalisation were possible, as it certainly seemed to be from the formulæ and explanations which Dr. Lapworth had advanced, his paper deserved, and would no doubt receive, the careful consideration of chemists.

Mr. A. G. BLOXAM asked whether, in the event of such tautomerism as that referred to by Dr. Lapworth occurring in di-substitution products, the second group would exert any preventive action on the wandering of the first group. Thus, supposing that a sulphonic group tended to wander into the next following γ -position, which, however, was already occupied by another group, would such a state of affairs determine the non-existence of a tautomeric form?

Dr. LAPWORTH, in replying, regretted that the time at his disposal had prevented him from saying all he had wished. He had tried, in the first instance, to show that a great many isomeric changes, including those of elimination of two groups attached to contiguous carbon atoms and also of most changes in benzenoid compounds, might be written in a form derived from that representing the relationship between the two forms of simple tautomeric substances, and had shown in the paper that they might be represented on exactly similar stereochemical bases. The latter he had omitted to give in reading, as it involved the introduction of the usual hypothetical space-relationships of carbon atoms and the idea of dissociation as distinct from decomposition, whilst the paper intended to call attention to what appeared to be a general type of change, logically deducible from a well-known form.

With regard to the production of benzenoid substitution-derivatives,

he had already pointed out that, as a rule, where substitution in the benzene nucleus undoubtedly occurs, ortho- and para-derivatives are the chief products, and that this fact, as also the question of the stability of a particular benzene derivative, must depend on some principle not intimately connected with the mechanism of isomeric change. A change, analogous to that of compounds of the aniline hydrogen sulphate type would afford meta-derivatives, and evidence of this is afforded by the production of metanitriline when aniline nitrate is treated with cold sulphuric acid; the production of ortho- and para-derivatives may then be due either to direct substitution in the ring, or to isomeric change of compounds of the phenylsulphamic acid or methylaniline type. Hence the formation of any particular acid from aniline, dimethylaniline, α - and β -naphthylamines, &c., is not difficult to account for, although the exact details of the production, or any one of them, would require a special discussion.

The convenience of employing the above formulæ and the apparently very general applicability of the type of change to which the author desired to draw attention, would only be understood when it was applied to cases which, as the author shows in his paper, are difficult to discuss on the usual bases.

In reply to Mr. Bloxam, the author said that the paper dealt with cases in which the γ -position was already occupied, and in the special case alluded to, the author's view made it clear that no entirely preventive action would be exercised, and this would appear to be in accordance with known cases.

At the next meeting, January 20th, 1898, there will be a ballot for the election of Foreign Members.

A LIST
OF THE
OFFICERS AND FELLOWS
OF
THE CHEMICAL SOCIETY.

CORRECTED TO MAY, 1897.

LONDON:
HARRISON & SONS, ST. MARTIN'S LANE,
Printers in Ordinary to Her Majesty.

1897.

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ABEL, SIR F. A., BART., K.C.B., D.C.L., F.R.S.

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HARCOURT, A. VERNON, D.C.L., F.R.S.

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ODLING, W., M.A., M.B., F.R.S.

PERKIN, W. H., LL.D., PH.D., F.R.S.

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WILLIAMSON, A. W., LL.D., F.R.S.

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REYNOLDS, J. EMERSON, M.D., F.R.S.

ROBERTS-AUSTEN, W. C., C.B., F.R.S.

TILDEN, WILLIAM A., D.Sc., F.R.S.

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THORPE, T. E., LL.D., F.R.S.

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OTHER MEMBERS OF COUNCIL

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YOUNG, SYDNEY, D.Sc., F.R.S.

EDITOR OF THE SOCIETY'S JOURNAL.

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SUB-EDITOR OF THE SOCIETY'S JOURNAL

A. J. GREENAWAY.

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ROBERT STEELE.

Date of Election.

Mar. 4, 1886		Allan, James Henry, 45, Walton-vale, Liverpool
Feb. 20, 1896		Allan, John, Salford Sugar Refinery, and 64, Fairlawn street, Moss Side, Manchester
Feb. 18, 1864	Trans.	Allen, Alfred Henry, 8, Broomfield-road, Sheffield
Dec. 6, 1894		Allen, F. J., Phoenix Chemical Works, Upper North-st., Poplar, E.
Dec. 3, 1891		Allen, George James, The Grange, Eccles Old Road, Pendleton, near Manchester
May 5, 1870		Allen, John, Phoenix Chemical Works, Upper North-street, Poplar, E.
May 3, 1894	Trans.	Allhusen, F. E., Harrow School, Harrow
Dec. 6, 1894		Allibon, G. H., 30, Donegal-place, Belfast
Dec. 6, 1894		Allport, J., M.A., 4, The Avenue, Kew Gardens, S.W.
Feb. 6, 1890		Allsom, Edward W., L.R.C.P., L.R.C.S., C.M.Ed., C.F.P.S.Glas., L.A.H.D., and P.S.I., 12, St. Patrick's-place, Cork
Mar. 5, 1885	Proc.	Amphlett, Edward Greenhill, M.A. Oxon, M.R.I., 2, Queen's Gate-terrace, S.W., and 3, Union-place, Worthing
Mar. 6, 1890		Anderson, Frederic Alfred, B.Sc., 30, Poplar-grove, West Kensington Park, W.
Feb. 21, 1895		Anderson, H., The Independent College, Taunton.
Dec. 15, 1892		Anderson, William Smellie, Marine Station, Granton
Feb. 2, 1883		Andrews, Edward Arthur, St. Mary's Hospital, Paddington, W.
May 4, 1882		Andrews, L. W., Ph.D., The University, Iowa City, Iowa, U.S.A.
Mar. 7, 1870		Andrews, Thomas, F.R.S., M.I.C.E., Ravenscrag, Wortley, near Sheffield
Feb. 15, 1877		Angell, John, 6, Beacon's Field, Derby-road, Withington, Manchester
Feb. 17, 1876		Ansdell, Gerrard, 3, Cross-lane, St. Mary-at-Hill, E.C.
June 19, 1879		Appleby, Herbert, Moorfield Chemical Works, Boothstown, near Manchester
Feb. 19, 1891		Appleton, Henry Austin, 2, Glenholme-terrace, Borough-road, Middlesboro'
May 15, 1890	Trans.	Appleyard, James Robert, University College, Dundee
Mar. 4, 1897		Arbuckle, William, 34, Moore-street, Cadogan-square, S.W.
Feb. 21, 1884		Archbutt, Leonard, The Yews, Madeley-street, Derby
Feb. 4, 1875		Armistead, William, M.B., C.M., Stapleford, Cambridge
Dec. 15, 1881		Armitage, Charles, Lancaster Corporation Gas Works, Lancaster
Dec. 1, 1870	Trans.	Armstrong, Henry E., LL.D., Ph.D., F.R.S., 55, Granville Park, Lewisham, S.E., and Central Institution, Exhibition-road, London, S.W.
Feb. 21, 1895		Arnot, J. Melrose, Bally Paper Mills, Uttara para, Upper Calcutta
May 3, 1894		Ashcroft, J. B., 96, Warner-street, Derby
May 3, 1894		Ashdown, Charles H., F.R.G.S., Monastery-close, St. Alban's
Dec. 18, 1884		Ashe, William Percy, M.D., 23, Cadogan gardens, S.W.
Mar. 4, 1897		Ashworth, J. B., 16, Ducie-street, Prince's Park, Liverpool

Date of Election.

Mar. 17, 1859	Trans.	Atkinson, E., Ph.D., Portesbery-hill, Camberley, Surrey
Mar. 7, 1872	Trans.	Atkinson, R. W., B.Sc., 44, Loudoun-square, Bute Docks, Cardiff
Jan. 16, 1862	Trans.	Attfield, Prof. J., F.R.S., 111, Temple-chambers, E.C., and Ashlands, Watford
Feb. 18, 1872	Trans.	Attwood, George, F.G.S., Assoc. Member Inst. C.E., Durmast House, Ringwood, Hants, and 18, St. Swithin's-lane, Cannon-street, E.C.
May 16, 1895		Auden, H. A., Gartenstrasse, 9, Tübingen, and Danesgate, Repton, Burton-on-Trent
Dec. 2, 1886		Audley, James A., B.Sc. Lond, A.R.C.Sc. Lond, F.I.C., 17, Gladstone-place, Hanley
Feb. 17, 1877		Austen, P. T., Ph.D., 876, President-street, Brooklyn, N.Y.
Dec. 15, 1892		Avery, David, Queen's College, University of Melbourne
Dec. 3, 1896		Aykroyd, H. E., Thornfield, Duckworth-lane, Bradford
Feb. 19, 1891		Aylan, John Charles, Manager Royal Laboratory, Royal Arsenal, Woolwich, S.E.
Dec. 16, 1875	Trans.	Bailey, G. H., Ph.D., D.Sc., Owens College, Manchester
Dec. 5, 1895		Bailey, G. P., B.A.
June 15, 1893		Bailey, Henry, 18, Lavender Sweep, S.W.
Feb. 21, 1884		Bain, Daniel, United Alkali Co., Allhuisen's Works, Gateshead
Dec. 3, 1891		Bairstow, John, Burley, Queen's Park, Chester
Dec. 5, 1889		Baker, Charles Frederic, Ph.D., Mason College, Birmingham
Dec. 6, 1883	Trans.	Baker, Charles J., The Schools, Shrewsbury
Feb. 17, 1881	Trans.	Baker, Harry, Maughland lane, Runcorn, Cheshire
June 19, 1884	Trans.	Baker, H. Brereton, Dulwich College, S.E.
May 4, 1893	Trans.	Baker, Julian L. Stamford, Hendham-road, Upper Tooting, S.W.
May 1, 1873		Baldock, John Henry, Overdale, St. Leonard's-rd., Croydon, Surrey
June 16, 1892		Ballantyne, Horatio, 75, Chancery-lane, W.C.
Dec. 18, 1884		Ballard, J. Farrow, 7, Queen's-parade, Cheltenham
Dec. 3, 1896		Ballingall, William, Ardarrock, Dundee
Dec. 3, 1891		Baly, Edward C. Cyril, University College, W.C.
Mar. 4, 1886		Bamber, H. K. G., c/o Messrs. Knight, Bevan, and Sturge, Northfleet
Dec. 4, 1890		Bamber, M. Kelway, 9, Victoria-street, S.W.
Feb. 2, 1888		Banner, Samuel, Sherwood. Sefton-park, Liverpool
Jan. 19, 1871		Bannister, Richard, Inland Revenue Laboratory, Somerset House, W.C., and 59, Tregunter-road, S. Kensington, S.W.
Dec. 2, 1880		Barclay, Arthur E., 95, Farringdon-street, E.C.
Mar. 4, 1897		Barclay, John, B.Sc., Avenue Cottage, near Bromsgrove, Worcestershire
Feb. 15, 1877		Bardsley, J., F.I.C., Church Works, Church, Lancashire

Date of Election.

Feb. 20, 1896	Barker, W. H., B.Sc., Glen Albyn Villa, Bridgend, South Wales
Dec. 1, 1870	Barklie, Robert, Linden Lodge, Jordanstown, Belfast
Dec. 6, 1894	Barlet, Stéphane, B.Sc., 47, Bassett-road, N. Kensington, W.
May 6, 1897	Barlow, H. W. L., M.A., M.B. Oxen, Holly Bank, Urmston, Manchester
May 6, 1897	Barlow, William, Hillfield, Muswell Hill, N.
Jan. 17, 1889	Barnes, Charles Lightfoot, 10, Nelson-st., Oxford-st., Manchester
May 7, 1891	Barnes, Edward Arthur, 194, Hammersmith-road, W., and Dynamite Works, Zuurfontein, S.A.R.
Dec. 2, 1875	Barnes, R. L., Phoenix Chemical Works, Hackney Wick, N.E.
Feb. 21, 1884	Barr, William Henry, M.D., Belgrave-place, Bury
Feb. 16, 1888	Barraclough, William H., F.I.C., Mortomley, near Sheffield
May 16, 1895	Barralet, E. S., 61, Thistlethwaite-road, Clapton, N.E.
Dec. 3, 1891	Barratt, J. Treeby, Bronhenlog, Mostyn, North Wales
Feb. 4, 1869	Barret, Edward L., B.Sc., 11, Rue de l'Hotel de Ville, Neuilly, Paris
Feb. 5, 1874	Barrett, Howard, M.R.C.S., M.R.C.P., 49, Gordon-square, W.C.
June 16, 1892	Trans. Barrows, Arthur Edward, Bloemfield Iron Works, Tipton, Staffordshire
Jan. 18, 1872	Barton, Robert, Royal Mint, Melbourne, Australia
April 19, 1883	Basker, J. A., Fore-street, Bridgwater
Feb. 18, 1864	Trans. Bassett, Henry, 26, Belitha-villas, Barnsbury, N.
May 7, 1891	Bate, William, National Explosives Co., Hayle, Cornwall
June 15, 1893	Bateman, John, Messrs. J. C. and J. Field, The Marsh, Lambeth, S.E.
May 7, 1891	Bater, Claude H., M.A., Inland Revenue, Ashwell, Baldock, Herts
Dec. 3, 1896	Bathurst, Charles, jun., B.A., Lydney-park, Gloucestershire
Dec. 3, 1896	Bay, L. H., The Grammar School, Carlisle
June 16, 1892	Bayliss, Charles, Selly Park, near Birmingham
Nov. 19, 1874	Bayly, F. W., The Royal Mint, E.
June 4, 1874	Bayne, James, Professor Royal Veterinary College, Camden Town, N.W.
June 19, 1879	Bayne, William Thirlwall, LL.D., Brookhill, Broad Clyst, Exeter
Dec. 4, 1873	Baynes, James, Ph.D., F.R.M.S., Borough Analyst's Office, Royal Chambers, Scale-lane, Hull
Feb. 19, 1891	Trans. Beadle, Clayton, The Rookery, Belvidere, Kent
Feb. 7, 1861	Beadnell, Major Charles Edward, R.A., 48, Castletown-road, W. Kensington
Dec. 5, 1867	Beale, William Phipson, Q.C., 10, New-court, Carey-street, Lincoln's-inn, W.C.; and 19, Upper Phillimore-gardens, Kensington, W.
Mar. 3, 1864	Beanes, Edward, Moatlands, Paddock Wood, Kent

Date of Election.

Mar. 6, 1890		Beardmore, G. Russell, D.P.H. Camb., L.R.C.P. Lond., M.R.C.S. Eng., L.S.A., Warwick House, Upper-street, Islington, N.
April 21, 1887		Beasley, William C. T., B.A., Fermain, St. Leonards-on-Sea
April 17, 1890	Trans.	Beck, Charles R., 118, Disraeli-road, Putney, S.W.
April 2, 1874	Trans.	Beckett, George Henry, Bo'fors, Vermland, Sweden
May 4, 1882		Beckett, John Hampden, Corbar Hill House, Buxton, Derbyshire
Feb. 6, 1879	Trans.	Bedson, P. Phillips, D.Sc., University of Durham, College of Physical Science, Newcastle-on-Tyne
Dec. 19, 1872	Trans.	Beilby, George T., St. Kitts, Slatford, N.B.
June 18, 1891		Belbin, T. St. J., 101, Piccadilly, W.
Dec. 6, 1888		Belcher, John Hope, B.A., Technical Institute, Coventry
May 7, 1891		Bell, Albert Edward, F.I.C., 2, Ellington-villas, Sherborne, Dorset
Dec. 2, 1886	Trans.	Bell, Chichester A., B.A., M.B. (Dublin), 3, Mansfield-place, Richmond, Surrey
June 20, 1889		Bell, E. Wightman, Spalding
Jan. 19, 1865	Trans.	Bell, J. Carter, the Cliff, Higher Broughton, Manchester
Dec. 3, 1863	Trans.	Bell, Sir Lowthian, Bart., F.R.S., Rounton Grange, Northallerton
Jan. 17, 1889		Bell, Percy Carter, The Cliff, Higher Broughton, Manchester
Dec. 4, 1879		Bemrose, Joseph, 56, St. Famille street, Montreal, Canada
Dec. 17, 1874		Bendix, David, Sutherland Lodge, 371, Romford-road, Forest Gate, E.
Nov. 19, 1874		Benger, Frederick Baden, F.I.C., The Grange, Knutsford, Cheshire
Feb. 17, 1881		Benjamin, Marcus, A.M., Ph.D., Smithsonian Institution, Washington, D.C., U.S.A.
April 15, 1836		Bennert, Carl, Ph.D., Godesberg, Germany
Feb. 20, 1896	Trans.	Bentley, W. H., B.Sc., 182, Liverpool-road, Irlam, near Manchester
Dec. 4, 1890		Bentz, Ernest, 5, Demesne-road, Whalley Range, Manchester
June 21, 1883		Beringer, Cornelius, Gilly House, Falmouth-road, Redruth
Feb. 16, 1882		Beringer, John J., Basset-road, Camborne, Cornwall
Dec. 5, 1895		Berkeley, The Earl of, Foscombe, Boar's Hill, near Abingdon
Mar. 6, 1890		Berncastle, Richard, 22, Aldridge-road Villas, Bayswater, W.
June 15, 1893		Berridge, Douglas J. P., M.A. Oxon, The Laboratory, Malvern College
Feb. 16, 1888		Berridge, Henry Dudley, M.A., Fotheringhay, Oundle, Northamptonshire
Dec. 7, 1882		Berry, Edward E., Villa Rosa, Bordighera, Italy
Dec. 3, 1891		Berry, Thomas William, Granville-terrace, Stone, Staffordshire
Dec. 6, 1888		Berry, William, 7, Hampton-park, Redland, Bristol
Dec. 15, 1892		Bersusan, Arthur J., 13, Lansdowne-road, Kensington-park, W., and Box 411, G.P.O., Sydney, N.S.W.

Date of Election.		
Mar. 1, 1883	Trans.	Bevan, Edward J., 4, New-court, Lincoln's-inn, W.C.
Dec. 2, 1886		Bevan, John William, care of Sir James Murray and Co., Chemical Works, Temple-street, Dublin
Dec. 7, 1865		Bickerdike, W. E., Bryers Croft, Wilpshire, near Blackburn
Feb. 18, 1875		Biggart, J. W., Chemical Laboratory, 29, Cathcart-street, Greenock
Mar. 7, 1872		Biggs, C. H. W., 140, Salisbury-court, Fleet-street. E.C.
Dec. 15, 1881		Bingley, John, Northampton
June 4, 1874		Bird, Henry, South Down House, Millbrook, near Plymouth
Feb. 15, 1894		Bird, William Rowland, 12, Gordon-road, New Swindon, Wilts
May 20, 1875	Trans.	Bischof, Gustav, Prof., 4, Hart-street, Bloomsbury
April 17, 1879		Black, A. H., F.R.G.S., St. John's, Wakefield
Dec. 2, 1886		Blackburn, Thomas, Aruba Phosphaat Maatschappij, Curaçoa, West Indies
Dec. 18, 1879		Blackett, Cuthbert R. Laboratory, Swanston-street. Old County Court, Melbourne
March 5, 1885		Blades, Chas. Mountain, Bay Villa, Chester-road, Northwich, Cheshire
Dec. 6, 1883		Blair, Frank A., Helsingfors, Finland
Mar. 6, 1890	Proc.	Blake, Robert R. F., Chemical Department, Queen's College, Belfast
May 15, 1890		Blake, William Henry, Clendon Tower, near Sunderland
June 3, 1875		Blanchard, Charles Thomas, M.A., F.I.C., The Firs, Summertown, Oxford
June 16, 1892		Bleckly, Arthur Sanderson, Thelwall Lea, near Warrington
Dec. 4, 1890		Blenkinsop, W. E. B., 15, Earlsfield-road, Wandsworth Common, S.W.
Feb. 20, 1896		Blood, M., B.A., 3, Stanley-terrace, Clifton-road, Norbiton
Feb. 19, 1891		Bloomer, Frederick John, F.I.C., 40, Summersfield-crescent, Rotton-park, Birmingham, and 15, Broderick-road, Upper Tooting
Ma 6, 1890	Trans.	Blount, Bertram, Laboratory, Broadway, Westminster, S.W.
Feb. 2, 1888		Bloxam, Arthur G., F.I.C., The Goldsmiths' Institute, New Cross, S.E., and 16, Bolingbroke-road, W. Kensington, W.
Dec. 20, 1883	Trans.	Bloxam, W. Popplewell, B.Sc. Lond., F.I.C., Royal Naval College, Greenwich, S.E.
May 16, 1895		Blume, E., P.O. Box 121, The Mexican Gold and Silver Recovery Co., Limited, 2a, de la Providencia No. 7, Mexico D.F., Mexico
Feb. 2, 1865	Trans.	Blunt, T. P., M.A., Tower-place, Shrewsbury
April 21, 1887		Blundstone, Edwin Richardson, B.A., Cornwall Lodge, Hampton Hill, Middlesex
Feb. 20, 1896	Trans.	Blyde, J. E. A., Nether House, Ranmoor, Sheffield
June 3, 1875		Blyth, Alexander Wynter, M.R.C.S., 29, Norfolk-road, N.W.

Date of Election.

May 5, 1892		Blyth, M. Wynter, B.A., B.Sc., 29, Norfolk-road, N.W.
Dec. 2, 1875		Boake, A., Wharton-road, Stratford, London, E.
Feb. 7, 1878		Bodmer, Richard, Analytical Laboratory, 16, Southwark-street, London, S.E.
Dec. 6, 1888		Bohm, William Dunsmore, A.R.S.M., F.I.C., 49, Avenue-road, Acton, W.
Mar. 18, 1869	Trans.	Bolas, Thomas, 60, Grove-park-terrace, Chiswick
Feb. 1, 1883		Bond, Henry C., M.A., Bromley Park School, Bromley, Kent
May 4, 1893	Trans.	Bone, William Arthur, Battersea Polytechnic, S.W.
Feb. 16, 1893		Boone, W. T., 7, Albert Place, Pittville, Cheltenham
Mar. 1, 1877		Borland, John, F.L.S., Etruria, Kilmarnock
April 17, 1884		Borland, W. D., Beacon Lodge, Green-street, Green, near Dartford, Kent
Mar. 17, 1881		Borns, Henry, Ph.D., 19, Alexandra-road, Wimbledon, S.W.
May 16, 1895		Borradaile, L. A., Selwyn College, Cambridge
Feb. 2, 1861		Bosanquet, R. H. M., F.R.S., c/o Messrs. Castle, Lamb and Storr, Salisbury-square, Fleet-street, E.C.
Feb. 15, 1894		Bose, Prof. Chuni Lal, 24, Mohendro Bose's-lane, Calcutta
June 16, 1881		Bostock, G. H., Broadbottom Hall, near Manchester
Dec. 15, 1881	Trans.	Bothamley, Charles H., F.I.C., Wentworth, Weston-super-Mare
June 16, 1887	Trans.	Bott, William, Ph.D., Raffles Institution, Singapore
Mar. 6, 1873		Bottle, Alexander, 4, Godwyn-road, Dover
June 15, 1871		Bottomley, James, B.A., D.Sc., Homer-terrace, 220, Lower Broughton-road, Manchester
May 15, 1869		Bottomley, James T., M.A., F.R.S., F.R.S.E., 13, University Gardens, Glasgow
Dec. 2, 1886		Bottomley, W. Beecroft, Ph.D., 15, Lillyville-road, Fulham, S.W.
Feb. 15, 1894		Boul, William Good, M.A., Tideswell Grammar School, near Buxton
Dec. 3, 1891		Bovell, John R., Dodd's Botanical and Experimental Station, Barbados
April 20, 1865		Bowdler, A. C., 20, Bank-terrace, Wellington-street, Blackburn
Dec. 6, 1888		Bower, Frank, 164, Marylebone-road, N.W.
May 3, 1894		Bowes, Harry, 53, Moss-lank, Higher Crumpsall, Manchester
Feb. 20, 1896		Bowley, J. J., 34, Elm-park-road, Chelsea, S.W.
Dec. 7, 1893		Bowman, Frederic Edmund, Mayfield, Knutsford, Cheshire
Nov. 6, 1862		Bowman, Frederick H., F.R.A.S., F.L.S., F.G.S., Mayfield, Knutsford, Cheshire
Feb. 20, 1896		Bowman, H. L., B.A., 13, Sheffield-gardens, Kensington, W.
Dec. 16, 1869	Trans.	Bowrey, J. J., Kingston, Jamaica
Dec. 6, 1894	Trans.	Boyd, D. R., B.Sc., The Hartley College, Southampton.
April 15, 1869		Braby, Frederic, Bushey Lodge, Teddington
Mar. 2, 1876		Bradley, Nathaniel, Sunnyside, Whalley Range, Manchester
May 16, 1895		Bradford, H., c/o E. G. Clayton, 32, Holborn-viaduct, E.C.

Date of Election.

June 21, 1888		Bradshaw, Charles, 10, The Nook, Barber-road, Sheffield
Mar. 17, 1881		Braga, J. F., F.G.S., F.L.S., F.R.G.S., 1, Albert-villas, High-road, Chiswick
Dec. 6, 1894		Brame, J. S. S., Royal Naval College, Greenwich
Nov. 20, 1890		Branson, Charles F., Frankfort House, West-side, Clapham Common, S.W.
Dec. 7, 1882		Branson, F. W., 14, Commercial-street, and Wynneholme, Fur-Headingley, Leeds
June 15, 1882	Trans.	Brauner, B., Ph.D., Spálená ulice, 1, Prague, Bohemia
Feb. 20, 1896		Bray, Daniel, Broadmoor, Cinderford, Gloucester.
Dec. 6, 1883		Briant, Lawrence, 24, Holborn-viaduct, E.C.
Dec. 4, 1890	Trans.	Brierley, John Thomas, 96, Bolton-road, Chorley, Lancashire
May. 4, 1893	Proc.	Briggs, John Frederick, Sugar Refinery, Sakri, near Darbhanga, Behar, India
April 19, 1883		Briggs, T. Lynton, 357, Madison-street, Brooklyn, New York, U.S.A.
Dec. 12, 1884		Briggs, William, 32, Red Lion-square, Holborn, W.C.
Feb. 6, 1890		Brindley, George F., Niagara Electro-Chemical Company, Niagara Falls, N.Y., U.S.A.
April 4, 1889		Broadbent, Harry, A.I.C., 125, Belle Vue-road, Leeds
Feb. 6, 1879		Broadbent, John J., Ellesmere House, Patricroft, near Manchester
Feb. 1, 1883		Brock, John, J.P., Gwern-Tyno, Colwyn Bay, N. Wales
Feb. 16, 1893		Brockbank, John Edwin, The Croft, Kirksanton, viâ Carnforth
Dec. 18, 1884		Brodie, Sir Benjamin V. S., Bart., Brockham Warren, Betchworth
Feb. 16, 1893		Brooke, Edward, West-court, Chalk, Gravesend, Kent
Dec. 16, 1886	Trans.	Brothers, H. E., F.I.C., B.Sc. Lond., Park-terrace, Tunstall, Staffs.
Jan. 17, 1884		Brough, Bennett Hooper, A.R.S.M., F.I.C., F.G.S., 28, Victoria-street, S.W.
May 4, 1876	Trans.	Brown, Adrian John, 6, Alexandra-road, Burton-on-Trent
Dec. 5, 1867	Trans.	Brown, Dr. A. Crum, F.R.S., 8, Belgrave-crescent, Edinburgh
Mar. 17, 1870		Brown, David, 93, Abbey-hill, Edinburgh
June 18, 1891		Brown, Edward, 32, Courlandsky-street, St. Petersburg, and care of Wm. Brown, Heaton-street, Cleckheaton
Mar. 20, 1873	Trans.	Brown, Frederic Douglas, Prof., B.Sc., Univ. Col., Auckland, New Zealand
Mar. 20, 1884		Brown, F. W., 43, Elgin-avenue, Maida Hill, N.W.
May 5, 1892		Brown, George Fitz, The Broughton Copper Company, Ditton, Copper Works, Widnes
June 17, 1880		Brown, Henry, Cannon Brewery, Watford, Herts
Jan. 19, 1871	Trans.	† Brown, H. T., F.R.S., 52, Nevern-square, Kensington, W.
Mar. 7, 1867	Trans.	Brown, James Campbell, D.Sc., Chemical Laboratory, Brownlow-street, Liverpool

Date of Election.

Mar. 16, 1881		Brown, Joseph, Ashleigh House, Savile Town, Dewsbury
Mar. 4, 1897		Brown, J. H., Dallas-place, Lancaster
May 4, 1893		Brown, Ralph E., c/o General Gold Extracting Co., Ltd., 1,530, Wynkoop-street, Denver, Colorado, U.S.A.
May 5, 1892		Brown, Reginald B., Yorkshire College, Leeds
Feb. 19, 1891		Brown, Robert John, The Technical School, Stockport
Dec. 18, 1884		Brown, William George, Ph.D., University of Missouri, Columbia, Missouri, U.S.A.
Dec. 3, 1896		Browne, C. E., 396, Clapham-road, S.W.
Dec. 7, 1893		Browne, Frank, Government Civil Hospital, Hong Kong
Feb. 20, 1873		Brownen, George, Vectis Villa, Gloucester-place, Boscombe, Bournemouth
Dec. 4, 1890		Brownsword, Frank, Shebbear College, Highampton, North Devon
Dec. 6, 1894	Trans.	Bruce, James, 10, Selwood-terrace, South Kensington, S.W.
May 16, 1895		Bruckmann, G. T., B.Sc., 192, Eighteenth-street, Brooklyn, N.Y.
Dec. 7, 1893	Trans.	Brunton, John Dixon, Wire Mill, Musselburgh, near Edinburgh
June 21, 1877		Buch, C. von, 20, Hanover-street, W.
June 21, 1877	Trans.	Buchanan, J. Y., F.R.S., 10, Moray-place, Edinburgh
May 4, 1893		Buchanan, Joshua, The New Transvaal Chemical Co., Ltd., 49, Green's Buildings, Commissioner-street, Johannesburg, S.A.R.
June 1, 1876		Buckmaster, C. A., 16, Heathfield-road, Mill-hill Park, Acton, W.
Mar. 1, 1852	Trans.	Buckton, G. B., F.R.S., Weycombe, Haslemere, Surrey
June 20, 1878		Budden, E. Russell, 11, Furnival-street, Holborn, E.C.
Dec. 20, 1842		Bullock, Lloyd, 3, Hanover-street, Hanover-square, W.
Mar. 6, 1890		Bunting, H. H., c/o The Peruvian Corporation, Baquijano, 276B, Lima, Peru
Feb. 20, 1896		Burbridge, J. K., Moor's Lea, Winchmore Hill.
Dec. 3, 1891		Burford, Samuel Francis, Eastleigh, Queen's-road, Leicester
Feb. 15, 1894	Proc.	Burgess, Herbert Edward, 16, Bloomsbury-street, W.C.
Dec. 5, 1889		Burgess, John, 7, Wellington-road, Peckham
June 19, 1884		Burgess, William Thomas, F.I.C., Beech-road, Reigate Hill.
Feb. 21, 1884		Burland, Jeffrey H., 824, Sherbrooke-street, Montreal
Dec. 6, 1894		Burman, G. W., Laboratory, The Shelton Iron, Steel, and Coke Co., Limited, Stoke-on-Trent, Staffs.
Mar. 19, 1849	Trans.	Burnard, Charles F., Plymouth Chemical Works, Chatsworth Lodge, Compton Gifford, Plymouth
June 4, 1885		Burnett, Joseph Fearon, 8, River View, Ashton, Preston
May 4, 1893		Burnett, William Robert, British Explosives Syndicate, Limited, Pitsea, Essex
May 4, 1893		Burnham, John Charles, Gunpowder Factory, Kirkee, Poona, India

Date of Election.

ay 4, 1882	Proc.	Burrell, B. Arthur, 5, Mount Preston, Leeds
Mar. 6, 1890		Burton, William, Clifton Junction, near Manchester
Feb. 21, 1884		Bush, Richard A., Holmdale, Baron-grove, Mitcham
Feb. 16, 1882		Bush, Baron William de, Artillery-lane, E.C.
Dec. 6, 1894		Bush, William, Austin Villa, Chepstow-road, Newport, Mon.
Dec. 5, 1889		Butcher, W. F., 32A, Lea-terrace, Blackheath, S.E.
Dec. 4, 1890		Butcher, William J., The Grammar School, Ashburne, Derbyshire
Feb. 21, 1895		Butler, D. Butler, 41, Old Queen-street, Westminster, S.W.
Dec. 4, 1890		Butler, William Waters, The Cedars, Duchess-road, Edgbaston, Birmingham
May 3, 1894		Buttmer, Robt. Wm., St. Mary's, Godalming
June 3, 1875		Butterfield, J. C., 79, Endlesham-road, Balham, S.W.
Feb. 18, 1892		Butterfield, W. J. Atkinson, M.A. Oxon, Ebor House, Redhill
Dec. 15, 1892		Buttfield, Horace Vincent, 13, Wellington-road, Bush Hill Park, Enfield, N.
June 15, 1893		Cahill, Robert S., 90, Park-lane, Norwich
Feb. 15, 1894	Trans.	Cain, John Cannell, D.Sc., Stubbins Villa, Stubbins, near Manchester
Dec. 7, 1893		Caines, C. M., 158, Elgin-avenue, Maida Vale, W.
Dec. 3, 1891		Calder, William A. S., Cawdor, Grove Park, Camberwell
June 19, 1884		Caley, Edward J., Eaton Old House, Norwich
June 18, 1896		Caley, John, 41, Norfolk-street, Beverley-road, Hull
Dec. 21, 1871		Calvert, J. H., Oakenshaw Print Works, near Acerington
Dec. 6, 1894		Cameron, Alex., Laboratory, 61-62, Chancery-lane, W.C.
June 17, 1875		Cameron, J. Macdonald, F.G.S., F.I.C., Royal Mint, Sydney, N.S.W.
May 4, 1893		Cameron, James, 11, Bolton-road, Port Sunlight, nr. Birkenhead
Dec. 15, 1892		Campbell, Andrew, Burmah Oil Works, Dunneadaw, Rangoon, Burmah
Dec. 6, 1888		Campbell, J. Morrow, B.Sc. F.R.G.S., c/o J. Morrow, Oakfield House, Anfield, Liverpool
June 7, 1888		Campbell, Rev. Joseph, St. Nicholas College, Randwick, N.S.W.
Feb. 20, 1896		Candy, Hugh, B.A., B.Sc., 101, Gower-street, W.C.
Mar. 20, 1884		Cannon, Matthew, Chemical Works, Wickersley-road, Lavender Hill, S.W.
Feb. 16, 1888		Carey, Alfred Edward, M.Inst.C.E., F.R.G.S., F.G.S., 39, Trinity-square, Tower Hill, E.C.
May 5, 1892		Carey, Arthur, B.Sc., Browside, Gateacre, near Liverpool
Feb. 21, 1889		Carmody, P., Prof., F.I.C., Government Laboratory Port of Spain, Trinidad
May 6, 1875		Carpenter, H. S., F.I.C., Beckington House, Weighton-road, Anerley, S.E.
Feb. 21, 1895	Trans.	Carr, Francis H., Meaburne, Warham-road, Croydon

Date of Election.

Nov. 17, 1887		Carrington, George Carrington, Missenden Abbey, Great Missenden, Bucks
Dec. 7, 1882		Carruthers, Robert, 90, High-street, Dumfries
Dec. 7, 1893		Carswell, Thomas Retson, 19, Cheetham-place, Cheetham Hill Manchester
June 16, 1864		Carteighe, Michael, 180, New Bond-street, W.
Mar. 4, 1897		Cartmell, Alfred, Alexander-road, Burton-on-Trent
Dec. 5, 1867		Carulla, F. J. R., 84, Argyle-terrace, Rose Hill-street, Derby
Feb. 21, 1895		Case, T. B., B.A., Beam Hall, Oxford
Feb. 6, 1879		Cassal, C. E., Vestry Hall, Mount-street, Grosvenor-square, W.
Dec. 6, 1894		Catherall, Ezra, 7, Portman-terrace, Taunton
Mar. 5, 1874		Chaloner, George, 30, Weston-park, Crouch End, N.
Dec. 2, 1880		Chamberlain, A. G., Rugby
Dec. 6, 1894		Chambers, J. F., Grammar School, Dursley, Gloucestershire
Dec. 20, 1883		Chambres, Gordon Crewe, Rev., Grammar School, Wigan
Feb. 1, 1883		Chance, Alexander M., Alkali Works, Oldbury, near Birmingham
Feb. 1, 1872		Chandler, Charles F., Ph.D., Columbia College, 41, East 49th-street, New York
Feb. 1, 1872		Chandler, William H., Prof., Lehigh University, Bethlehem, Pennsylvania
Feb. 21, 1889		Chaplin, Edward Mitchell, Ph.D., 60, Westgate, Wakefield
Dec. 5, 1895		Chapman, A. J., Burleigh House, Yerbury-road, Upper Holloway, N.
June 17, 1886	Trans.	Chapman, Alfred C., F.I.C., 23, Leadenhall-street, E.C.
Jan. 16, 1868		Chapman, Edward, Hill End, Mottram, Manchester
Dec. 18, 1884		Chapman, Herbert M., The War and Sporting Smokeless Powder Company, Trimley, Suffolk
May 7, 1891		Charles, Rhys Pendrill, Plâs Newydd, Neath
Feb. 15, 1894	Trans.	Chattaway, F. D., D.Sc. Lond., Ph.D. Mun., B.A. Oxon., Chemical Laboratory, St. Bartholomew's Hospital, E.C.
Dec. 5, 1895		Chattaway, W., Apothecaries' Hall, E.C.
May 16, 1895		Cheadle, Walter W., B.A., 19, Portman-street, W.
Dec. 4, 1890		Cheetham, T. A., Allan Glen's School, 68, North Hanover-street, Glasgow
Dec. 5, 1878		Cheshire, H. F., Public Analysts' Laboratory, Hastings
Jan. 19, 1882		Chester, Edward D., 120, Bishopsgate-street Within, E.C.
Dec. 16, 1875		Cheverton, George, F.L.S. South Lawn, Tunbridge Wells
Jan. 16, 1868		Child, Gilbert W., Holywell Lodge, Oxford
Dec. 21, 1871		Childs, Christopher, M.D., Oxon, 10, Manchester-square, W.
Mar. 4, 1897		Cholerton, A. F., Lyndum House, Lincoln-street, Leicester
Dec. 3, 1891	Trans.	Chorley, John C., Lodge-lane, Bewsey, Warrington
Dec. 17, 1885		Christopher G., Walkden Works, Verney-road, Bermondsey, S.E.
Dec. 7, 1882		Chrystal, William J., 7, West George-street, Glasgow; and Shawfield Works, Rutherglen, near Glasgow

Date of Election.

Mar. 3, 1856	Trans.	Church, Arthur Herbert, F.R.S., Shelsley, Kew, Surrey
April 19, 1888	Trans.	Claisen, Ludwig, Ph.D., Chemisches Laboratorium, Technische Hochschule, Aachen, Prussia
Dec. 15, 1892		Clark, Ernest Victor, 34, St. Anbys, Hove, Sussex
Dec. 7, 1876	Trans.	Clark, John, Ph.D., 138, Bath-street, Glasgow
Feb. 16, 1852	Trans.	Claudet, Frederic, 6, Coleman-street, E.C.
April 15, 1886		Clayden, Arthur W., M.A., F.G.S., St. John's, Polsloe-road, Exeter
Dec. 7, 1882		Clayton, E. Godwin, F.I.C., 32, Holborn-viaduct, E.C.
May 4, 1893		Clayton, George, School of Pharmacy, 100, Burlington-street, Manchester
Feb. 21, 1889		Clayton, John William, Bentfield, Alma-road, Aigburth, Liverpool
Dec. 4, 1873	Trans.	Cleminshaw, Edward, M.A., Alkali Works, Oldbury, near Birmingham
May 20, 1875		Clerk, Dugald, 18, Southampton-buildings, Chancery-lane, W.C.
May 19, 1856		Clift, Samuel, 63, Dudley-road, West Bromwich
Feb. 7, 1878		Clond, Thomas Charles, A.R.S.M., Walaroo Smelting Works, Walaroo, South Australia
Mar. 18, 1869	Trans.	Clowes, Frank, D.Sc., University College, and Tattershall Corner, The Park, Nottingham
Feb. 3, 1887		Coates, William Henry, M.A., M.B., L.S.Sc., M.R.C.S., L.R.C.P., L.S.A., Bleak House, Patrington, Yorkshire
Dec. 3, 1896		Cobb, W. W., M.A., Hilton House, Atherstone
Mar. 6, 1890		Cobbold, Paul Alexander, M.A., Haileybury, Ontario, Canada
May 16, 1895		Coblentz, V., 115-119, W. 68th-street, New York
Dec. 18, 1879		Cochran, Michael, M.A., Wiesbaden, Kollupitiya, Colombo, Ceylon
Dec. 2, 1880		Cockburn, Arthur Cecil, 22, Streatley-road, Brondesbury, N.
Dec. 5, 1895		Cockburn, G. B., B.A., St. George's Hospital, S.W.
Dec. 7, 1893		Cocking, Allan Thomas, Rowley Robert-road, Handsworth, Birmingham
Feb. 16, 1888		Cocking, Lewis Smith, Wharf Mills, Apsley, Huddersfield
Feb. 17, 1881		Coffin, Walter H., 94, Cornwall-gardens, South Kensington, and Junior Athenæum Club, S.W.
Mar. 5, 1885	Trans.	Cohen, Julius B., Yorkshire College, Leeds
Feb. 19, 1891	Trans.	Colefax, Arthur, Ph.D., M.A., 4, Brick-court, Temple, E.C.
April 19, 1883		Coleman, Joseph Bernard, S.W. Polytechnic Institute, Manresa-road, Chelsea, S.W.
June 21, 1883		Coleman, T. H., Bryn Edwyn, Regent-street, Wrexham
Mar. 1, 1883		Collenette, Adolphus, 11, Commercial-arcade, Guernsey
Nov. 6, 1873		Collens, Edward, Stourbank House, Stourport, Worcester-shire
June 16, 1881		Collett, John Marton, Guys Cliff, Wotton, Gloucester

Date of Election.

Feb. 5, 1885	Trans.	Collie, J. Norman, Ph.D., F.R.S., 16, Campden-grove, Kensington, W.
Feb. 18, 1892		Collins, Hugh Brown, B.Sc., 121, West George-street, Glasgow
Feb. 6, 1890		Collins, Sydney Hoare, East Lynne, Dehra Dun, N.-W. Prov., India
Feb. 16, 1888		Collins, W. Hepworth, Bradford-buildings, Bolton
Mar. 17, 1887	Trans.	Colman, Harold G., Ph.D., 23, Stirling-road, Edgbaston, Birmingham
May 15, 1890		Colwell, James Kear, F.I.C., Clerkenwell Town Hall, Roseberry-avenue, E.C.
May 5, 1892		Comyns, Frank B. A., 6, Montague-terrace, Newbury, Berks
June 18, 1891		Congdon, Prof. Ernest A., The Drexel Institute of Art, Science, and Industry, Chestnut-street, Philadelphia, Penn, U.S.A.
Feb. 18, 1875		Connor, Charles C., B.A., Notting-hill House, Malone, Belfast
April 19, 1883		Conrad, Edwin C., 12, Briggs-street, Norwich
Feb. 15, 1877		Conroy, Michael, Woodstock, New Brighton, Cheshire
Jan. 18, 1866	Trans.	Conroy, Sir John, Bart., F.R.S., Balliol College, Oxford
Dec. 2, 1875	Trans.	Cook, E. H., D.Sc. (Lond.), the Clifton Laboratory, 27, Berkeley-square, Clifton, Bristol
Nov. 5, 1874		Cook, Edward Rider, East London Soap Works, Bow
May 16, 1895		Cook, Herbert W., Prestburg-villa, Park-lane, Macclesfield
Dec. 4, 1890		Cooke, Arthur William, c/o W. Bettel, Esq., Box 647, Johannesburg, S.A.R.
Feb. 2, 1888		Cooke, F. Barker, F.I.C., Messrs. Bostock and Co., South Dock, Garston, near Liverpool
Nov. 15, 1888		Cooley, Walter Bromley, 5, Dudley-street, Wolverhampton
April 17, 1897		Coombes, W. Johnstoun, Pilmuir, Falmouth, Cornwall
Jan. 17, 1889		Cooper, Albert, Grimston Lawn, Haven Green, Ealing, W.
Dec. 15, 1892		Cooper, Arthur James, Minavon Park-avenue, Worcester
Feb. 16, 1888		Cooper, Astley, Oatlands Chemical Works, Meanwood-road, Leeds
May 7, 1891		Cooper, Walter Johnson, South Wales Cement Works, Penarth, near Cardiff
Dec. 6, 1894	Proc.	Coote, A. H., 1, Mycene-road, Blackheath, S.E.
April 15, 1880		Copas, Edwin Charles, M.A.
Feb. 6, 1890		Coppock, J. B., Harris Institute, Preston
Feb. 19, 1891	Trans.	Corbett, Charles Henry, the Avenue, Trowbridge, Wilts
Mar. 1, 1866		Corfield, W. H., M.A., M.D. (Oxon), F.G.S., Professor of Hygiene and Public Health, University College, W.C., and 19, Saville-row, W.
Dec. 6, 1888		Cornish, Vaughan, Branksome Cliff, Bournemouth.
April 17, 1890		Corrie, David, Nobel's Explosives Company, West Quarter Factory, Polmont Station, N.B.
Dec. 3, 1891		Cory, G. E., M.A., St. Andrew's College, Grahamstown
June 15, 1893	Trans.	Coste, John Henry, 206, Amlurst-road, Hackney, N.E.
June 16, 1892		Couldrey, Henry, H.M.'s Mint, Bombay, India

Date of Election.

Dec. 17, 1885		Cousins, William J., 11 and 12, Southampton-buildings, Chancery-lane, W.C.
Dec. 16, 1886	Trans.	Coutts, Francis J. H., Green Mount, Plymouth-grove, Manchester
Dec. 7, 1882		Cowie, Thomas R., Merchant-street, Rangoon, Burmah
Feb. 6, 1873		Cownley, Alfred J., 13, Fenchurch-avenue, E.C.
April 19, 1888		Cowper, Joseph, 50, King-street, Penrith
Dec. 2, 1886		Cox, Ebenezer John, Orwell Bank, Greenfield-road, Harborne, Birmingham
Dec. 4, 1873		Cox, Samuel Herbert, 13. St. Helen's-place, London, E.C.
Dec. 1, 1870	Trans.	Crafts, Prof. J. M., 59, Marlborough-street, Boston, Mass., U.S.A.
Dec. 15, 1892		Craig, Andrew William, 77, Peel-street, North Melbourne, Victoria
Feb. 20, 1896		Craig, James, M.A., B.Sc., 4, West Garden-street, Glasgow
June 3, 1875		Crampton, George, St. George's Club, Hanover-square, W.
Dec. 7, 1893		Craw, John A., Bertheau Str. 6, Göttingen
Mar. 16, 1882		Crawley, H. Howard, Saugeen School, Bournemouth
Mar. 4, 1897		Creasey, C. H., 78, Baggeholme-road, Lincoln
May 20, 1875		Cresswell, Charles Gerard, Ermyngarth, Ashtead
Mar. 3, 1887		Cribb, Cecil H., B.Sc., 136, Shaftesbury-avenue, W.
April 4, 1889		Cridland, Francis E. J., Analytical Laboratory, 192, Palmerston-buildings, Old Broad-street, E.C.
June 20, 1878		Criper, William Risdon, Chemical Works, Konnagar, Calcutta
Dec. 5, 1895		Crocker, C., St. Peter's-road, Cockett, Swansea
May 20, 1886	Trans.	Crompton, Holland, Heath-house, New End-square, Hampstead
Dec. 3, 1857	Trans.	Crookes, Sir William, F.R.S., 7, Kensington Park-gardens, W., and Athenæum Club, Pall Mall, S.W.
Feb. 6, 1879	Trans.	Cross, Charles Frederick, 4, New-court, Lincoln's-inn, W.C.
Dec. 3, 1896		Cross, G. H., B.Sc., Balliol College, Oxford
Dec. 4, 1890	Trans.	Crossley, Arthur W., M.Sc. (Vict.), Ph.D., Chemical Laboratory, St. Thomas's Hospital, S.E.
June 18, 1896		Crossman, C. M., B.Sc., 23, Euston-buildings, N.W.
Feb. 21, 1895		Crossman, Tom, 40, Coldhurst-street, Oldham.
Dec. 2, 1880	Trans.	Crow, John Kent, D.Sc., 23, Vanburgh-hill, Blackheath, S.E.
Dec. 1, 1887		Crowther, H. Woodward, The Beeches, West Bromwich
Mar. 4, 1897		Crowther, James, B.Sc., West-field, Lightcliffe, Halifax
June 20, 1895		Croysdale, John, Whitley Bridge, R.S.O., Yorkshire
June 19, 1884		Crumbie, William D., 146, Washington-street, East Orange, New Jersey, U.S.A.
Mar. 17, 1887	Trans.	Cundall, J. Tudor, B.Sc., Edinburgh Academy, Henderson-row, and 1, Deom-park-crescent, Edinburgh
Dec. 27, 1875		Curphey, W. S., 15, Bute-mansions, Glasgow
Dec. 15, 1881		Custance, John D., Prof. of Agriculture, Forest-hill-house, near Newport, Isle of Wight
Dec. 5, 1895		Cuthbertson, Gurney, 69, Shoreham-street, Sheffield

Date of Election.		
Feb. 15, 1894		Dains, Herbert H., F.I.C., c/o Messrs. Macfadren and Co., Winchester-house, Old Broad-street, E.C.
Dec. 7, 1882		Dampier, Henry L., Hill Brow, Strood, Kent
June 16, 1887		Daniell, L. C., Royal Standard Brewery, Tamworth, N.S.W.
April 15, 1850		Danson, Joseph,
Feb. 18, 1892		Darbshire, Francis V., Rossplatz 12, I., Leipzig
Nov. 15, 1852		Darby, Stephen, 140, Leadenhall-street, E.C.
Dec. 3, 1891		Darling, Thomas, Adderstone House, Berwick-on-Tweed
May 4, 1871	Trans.	Darling, William Howarth, 126, Oxford-street, Manchester
Nov. 8, 1886		Davenport, Bennett F., M.A., M.D., 161, Tremont-street, Boston, Mass., U.S.A.
Nov. 18, 1875		Davey, G. W., Bleak House, Barking Creek
Feb. 16, 1893		Davey, George, 111, Windmill-street, Gravesend
May 18, 1876		Davidson, Joseph, Green Bank, Holywell-green, near Halifax
Feb. 1, 1866	Trans.	Davies, Arthur E., Ph.D., Tweedbank, West Savile-road, Edinburgh
May 6, 1858	Trans.	Davies, Edward, The Laboratory, 28, Chapel-street, Liverpool
Feb. 16, 1882	Trans.	Davies, G. W., 8, Spring-hill, Stockport
Feb. 15, 1894		Davies, S. H., Rowntree's Cocoa Works, York.
June 18, 1896		Davies, J., Bute Chambers, Bute-road, Cardiff
Dec. 17, 1857		Davis, J. Frederick, F.G.S., Archbrook, Budleigh-Salterton, Devon
June 6, 1872	Trans.	Davis, Richard Hayton, 26, Regent-parade, Harrogate
Jan. 20, 1876		Davis, T. Sebastian, 199, South Lambeth-road, S.W.
Mar. 4, 1897		Davis, W. A., Merton-house, Braintree, Essex
Dec. 7, 1876		Davis, Walter Charles, The Chestnuts, Durdham Down, Bristol
Feb. 21, 1895		Daw, F. W., Eureka-place, Ebbw Vale, Monmouthshire
Nov. 20, 1890		Day, Charles Edwin, 145, Abbey-road, Barrow-in-Furness
Mar. 17, 1881	Trans.	Day, T. Cuthbert, 36, Hillside-crescent, Edinburgh
Mar. 4, 1886		Deane, Leo. M., Chemical Research Laboratory, Messrs. Kynock, Limited, Lion Works, Witton, Birmingham
Mar. 3, 1859	Trans.	Debus, Heinrich, Ph.D., F.R.S., 4, Schlangenberg, Cassel, Provinz Hessen, Germany
May 7, 1885	Trans.	Dechan, Martin, Chemical Laboratory, 5, Oliver-place, Hawick
Dec. 3, 1874		Deck, Arthur, 9, King's-parade, Cambridge
April 1, 1869	Trans.	Deering, W. H., 9, Harvey-villas, Hervey-road, Blackheath, S.E.
Dec. 15, 1881		Demarcay, Eugene Anatole, 8bis, Bd. de Courcelles, Paris
Dec. 15, 1892		Denison, Joseph R., 1, Park-view-terrace, Manningham, Bradford
Mar. 6, 1890		Dennant, John, F.G.S., Russell-street, Camberwell, Victoria
Dec. 1, 1870	Proc.	Dewar, James, Prof., M.A., LL.D., F.R.S., Royal Institution, Abermarle-street, W.
Mar. 4, 1886		Dey, Preo Lal, 4, Beadon-street, Calcutta

Date of Election.

June 17, 1880		Dey, Kanny Lall, Rai Bahadur C.I.E., 4, Beadon-street, Calcutta
Mar. 4, 1897		Diamond, William, Pyebridge, Alfreton, Derbyshire.
April 15, 1880		Dibdin, W. J., F.I.C., Mayfield, Grange-road, Sutton, Surrey
April 18, 1872		Dickenson, Arthur John, F.I.C., 4, Shadeloes-road, New Cross, S.E.
May 4, 1893		Dickinson, Henry Winram, South Kensington Museum, S.W.
Dec. 1, 1887		Dickson, T. Arthur, Estate Office Overstone Park, Northampton
Feb. 2, 1860	Trans.	Divers, Edward, Prof., M.D., F.R.S., Hongo, Tokyo, Japan
Feb. 5, 1885	Trans.	Dixon, Augustus Edward, M.D., Queen's College, Cork
Feb. 20, 1896		Dixon, Frank, B.Sc., The Foundation School, Whitechapel-road, E.
June 7, 1894		Dixon, George, B.A., Trinity College, Cambridge and St. Bees, S.O., Cumberland
Feb. 3, 1876	Trans.	Dixon, Harold B., F.R.S., Owen's College, Manchester
May 4, 1893		Dixon, Harry W., 20, Moor-crescent, Hunslet, Leeds
Dec. 5, 1895		Dixon, W., 102, Spring street, Bury
Dec. 18, 1862		Dixon, W. A., Technical Coll., Harris-street, Sydney, N.S.W.
April 17, 1890		Dixon, William, 4, Park-place East, Sunderland
June 15, 1882	Trans.	Dobbie, James Johnstone, M.A., D.Sc. University College, Bangor, N. Wales
Mar. 3, 1887	Trans.	Dobbin, Leonard, Ph.D., Chemical Laboratory, New University-buildings, Edinburgh
Dec. 2, 1875	Trans.	Dodd, T. H., Chemical Department, Royal Arsenal, Woolwich, S.E.
April 19, 1888		Dodd, William Henry, 8, Kempson-road, Walham-green, S.W.
Nov. 18, 1886		Dodd, W. Ralph, Oakdene, Bush-hill Park, Enfield
May 5, 1892		Dodds, George Price, 9, Day-street, Sandysford-road, Newcastle-on-Tyne
Dec. 6, 1894	Proc.	Doherty, W. M., Government Laboratory, Sydney, N.S.W.
June 7, 1894	Trans.	Donald, George, 1, Park-terrace, Longside, Glasgow
May 5, 1892		Donaldson, Hudson, The Laurels, St. Catharine's-road, Grantham
May 20, 1886	Trans.	Doran, Robert Elliott, Chemical Dept. Queen's College, Cork
May 20, 1886		Dormer, Richard, Garston.
Dec. 6, 1888		Douglas, William, A.I.C., Diamond, Demerara, British Guiana
Nov. 20, 1884		Down, Frederick J., Glengariff, Milton-road, Harpenden, Herts.
Feb. 3, 1887		Downes, Arthur H., M.D., Local Government Board, Whitehall, S.W.
Feb. 21, 1884		Draper, Henry Carter, The Lodge, Clonsilla, co. Dublin
June 18, 1891		Dreaper, W. Porter, Clifton Villa, Coggeshall-road, Braintree, Essex.
Feb. 16, 1893		Dreyfus, Charles, Ph.D., The Clayton Aniline Co., Clayton, Manchester
May 16, 1895		Druce, E., Agricultural College, Holmes Chapel, Cheshire

Date of Election.

Dec. 4, 1890		Dudley, William L., Prof. Vanderbilt Univ., Nashville, Tennessee, U.S.A.
Feb. 16, 1893	Trans.	Dufton, Samuel Felix, B.A., D.Sc., 6, Park-road, Red Hill, Surrey
Mar. 4, 1897		Duffy, Lawrence, 33, Broomhall-place, Sheffield
May 5, 1892		Duffield, Walter William, 5, Ashington-road, Parson's-green, S.W.
Feb. 21, 1884		Duggan, T. R., Sunny-bank, Vanburgh-hill, Westcombe-park, Blackheath, S.E.
Jan. 17, 1889		Duisberg, Dr. Carl, Elberfeld, Germany
Dec. 5, 1889		Dukes, Thomas William, P. T. Peterson and Co., P.O. Box 210, Johannesburg, S.A.R.
June 16, 1881		Duncan, Arthur W., 42, Trevelyan-street, Eccles, Manchester
Dec. 6, 1894	Proc.	Duncan, C. C., Royal Agricultural College, Cirencester
Dec. 17, 1863		Duncan, James, 9, Mincing-lane, E.C.
Feb. 15, 1894		Duncan, Dr. John, St. Petersburg, Russia
June 18, 1891		Duncan, William, The Laboratory, 65, Bath-row, Edgbasten, Birmingham
Dec. 3, 1896		Duncan, William, Royal Dispensary, 21, W. Richmond street, Edinburgh.
Dec. 6, 1894	Proc.	Dunn, Fred., 316, Flinders-lane, Melbourne
June 7, 1888		Dunn, John, B.Sc., Morgan Academy, Dundee
Dec. 7, 1882		Dunn, J. T., D.Sc., Northern Polytechnic Inst., Holloway, N.
Feb. 16, 1893		Dunnington, Francis P., University of Va, Charlottesville, U.S., N.A.
Dec. 3, 1885		Dunstan, M. J. R., M.A., F.R.S.E., Newcastle Circus, The Park, Nottingham
Dec. 18, 1879	Trans.	Dunstan, Wyndham R., Prof., M.A., F.R.S., Scientific Department, Imperial Institute, S.W
Jan. 19, 1860	Trans.	Dupré, August, Ph.D., F.R.S., Westminster Hospital Medical School, Caxton-street, Westminster, S.W.
May 7, 1896		Durant, H. T., P. O. Box 1891, Rand Central Ore Reduction Co., Johannesburg, S.A.R.
June 1, 1871		Durham, Henry, 32, Fitzroy-street, Fitzroy-square, W.
Dec. 6, 1883	Proc.	Durrant, Reginald G., M.A., The College, Marlborough, Wilts
Dec. 6, 1894		Dutson, L. B.
Dec. 6, 1883		Dutta, Ramchandra, Medical College, Calcutta
Dec. 15, 1892		Duxbury, Thomas, 4, Grosvenor-chas., Deansgate, Manchester
Dec. 16, 1875	Trans.	Dyer, Bernard, D.Sc. (Lond.), 17, Great Tower-street, E.C.
Feb. 6, 1890	Trans.	Dymond, Thomas Southall, 78, Duke-street, Chelmsford
Nov. 19, 1885	Trans.	Dyson, Gibson, Ph.D., Homefield, Middleton-road, Higher Crumpsall, Manchester
Mar. 1, 1883	Trans.	Dyson, Septimus, 2, Exchange-place, Middlesbrough
Feb. 7, 1882		Earl, Alfred George, M.A., Ferox Hall, Tonbridge

Date of Election.

Dec. 1, 1876		Earp, Francis S., Ph.D., Hannan's Brown Hill Mine, Kalgoorlie, W.A.
April 4, 1889	Trans.	Easterfield, Thomas Hill, M.A., Ph.D., 60, Bateman-street, Cambridge
Dec. 3, 1891		Eastick, Charles E., Martineau's Refinery, King Edward-street, Whitechapel, E.
Feb. 1, 1881		Eastick, John J., Millaquin Refinery, Bundaberg, Queensland
Dec. 5, 1878	Trans.	Eccles, Herbert, Faun Villa, Briton Ferry, and Briton Ferry Steel Works, Glamorgan
Mar. 17, 1881		Edgell, R. Arnold, Rev., M.A., The College House, Leamington
June 1, 1876		Edmunds, James, M.D., 29, Dover-street, Piccadilly, W.
Feb. 7, 1848	Trans.	Edwards, John B., Ph.D.
May 4, 1893		Edwards, Thomas, Brewery House, Rhymney, viâ Cardiff
Feb. 21, 1884		Edwards, Vincent, Lawes' Chemical Manure Co., Barking Creek, Essex
Mar. 4, 1897		Edwards, W. B., 5, Garlinge-road, Brondesbury, N.W.
May 5, 1892		Edwards, Walter N., 4, Herne Hill-road, Camberwell, S.E.
June 16, 1887		Ehrhardt, Ernest Francis, D.Sc., Ph.D., A.M.C. Anilinfabrik Ludwigshafen-am-Rhein
Nov. 20, 1884		Ehrmann, Leon, P.O. Box 932, Johannesburg, S.A.R.
Feb. 20, 1896		Eiloart, Arnold, Ph.D., The Colony, Purleigh, Essex
Dec. 1, 1864	Trans.	Ekin, Charles, 143, New Bond-street, W.
Dec. 20, 1883		Ekins, Arthur E., County Laboratory, St. Albans
Nov. 17, 1887		Elborne, William, B.A. (Cantab.), University College Hospital, W.C.
Dec. 3, 1891		Elford, Percy, St. John's College, Oxford
Feb. 7, 1878		Elliott, Arthur H., Ph.D., c/o Consolidated Gas Co., 4, Irving-place, New York City, U.S.A.
Dec. 3, 1896	Trans.	Elliott, W. J., M.A., Grammar School, Bristol
Dec. 7, 1893		Ellis, C. Sordes, A.I.C., 24, Athol-terrace, Rusholme, Manchester
April 17, 1890		Ellis, Thomas Flower, Widmore, Bromley, Kent
Feb. 7, 1878		Ellis, W. H., School of Practical Science, Toronto, Ontario, Canada
May 5, 1892		Ellison, Henry, junr., Whitechapel-road, Cleckheaton
Mar. 15, 1888		Ellwood, Thomas Ashcroft, 75, Cavendish-road, Harringay, N.
Feb. 16, 1893		Elmore, Alexander Stanley, The Old Hall, Knostrop, near Leeds
Mar. 4, 1886	Trans.	Elworthy, Herbert Samuel, 19, Hill-road, Baudra, Bombay
Feb. 5, 1885		Embrey, George, Oriel Lodge, Tuffleigh, near Gloucester
Feb. 3, 1887		Emmons, Hamilton
May 16, 1895		Engineer, Dr. K. S., Marine Lines Station, Bombay
June 16, 1892		Entwistle, Herbert, Fairholm, Marsland-road, Sale
Dec. 3, 1885		Epps, James, junr., Norfolk House, Beulah Hill, Upper Norwood, S.E.
Dec. 5, 1889		Erskine, J. Kerr, c/o George Goch, G.M. Co., Box 540, Johannesburg, S.A.R.

Date of Election.

June 21, 1883	Trans.	Esilman, Alexander, Fleetwood Lodge, 25, Roe-lane, Southport
May 1, 1862		Esson, William, F.R.S., Merton College, Oxford
Feb. 2, 1865		Estcourt, Charles, 20, Albert-square, Manchester
Feb. 2, 1888		Estcourt, Philip Anderson, Chemical Laboratory, 20, Albert-square, Manchester
June 7, 1894		Eumorfopoulos, Nicholas, B.Sc., 1, Kensington Park-gardens, W.
Mar. 16, 1895		Eutroppe, A. T., Vancouver, Washington, U.S.A.
May 7, 1891		Evans, Frederick Arthur, The Cape Copper Co., Ookiep, Namaqualand, Cape of Good Hope
June 15, 1876		Evans, Gwilym, 7, Stepney-street, Llanelly, South Wales
May 4, 1893	Trans.	Evans, Robert Cecil Turle, 2, Clarence-road, Brondesbury
June 16, 1892		Evans, Sir John. D.C.L., LL.D., K.C.B., F.R.S., Nash Mills, Hemel Hempstead
Dec. 6, 1888		Everard, Arthur George, 27, Northcote-road, Clapham Junction, S.W.
Feb. 15, 1894		Evershed, Frank, Kenley, Surrey
Feb. 20, 1896	Trans.	Ewan, Thomas, M.Sc., Ph.D., The Aluminium Co., Ltd., Oldbury, near Birmingham
Dec. 3, 1896		Ewen, E. D., c/o The West Indian Tobacco Co., Port of Spain, Trinidad
Mar. 15, 1888		Faber, Harold N., Fiona, Lennard-road, Penge, S.E.
May 18, 1865	Trans.	Fairley, Thomas, F.R.S.E., 17, East-parade, Leeds
Feb. 1, 1883		Fallon, J. H. M., Casilla, 232, Lima, Peru
Nov. 15, 1888		Farlie, John B., 6, Ripon-villas, Ripon-road, Plumstead, S.E.
Feb. 21, 1895		Fairrie, Henry, 253, Vauxhall-road, Liverpool.
Dec. 5, 1895		Farr, E. H., Uckfield, Sussex
Dec. 1, 1870		Farries, Thomas, 16, Coleman-street, E.C.
Dec. 2, 1880		Farrington, Thomas, M.A., 5, Summerhill-terrace, Wellington, Cork
Dec. 5, 1895		Fauvel, C. J., Laboratory, Cranford, Middlesex
Feb. 15, 1894		Fawcett, Joseph Addey, 54, Broxholme-road, Doncaster
May 16, 1895		Fawns, Sidney, F.G.S., A.I.M.M., P.O., Coolgardie, W.A.
Dec. 1, 1837		Fawsitt, Charles A., 9, Foremount-terrace, Dowanhill, Glasgow
ay 17, 1838	Trans.	Fell, John Campbell
Dec. 5, 1873		Fenton, H. J. H., M.A., Christ College, Cambridge, and 7, Mortimer-road, Cambridge
June 20, 1872		Ferguson, John, Prof., M.A., University of Glasgow
Feb. 4, 1864		Ferreira, A. A., M.P.S.
Feb. 21, 1889		Ferrier, David, 1, Edin-terrace, Perth
Nov. 16, 1882		Ferrier, James, Columbus, Georgia, U.S.A.
Dec. 5, 1895		Fielding, P. J. D., 8, St. Joseph's-place, Cork.
May 15, 1890		Findlay, George H., Burmantoft's Brewery, Leeds
May 7, 1896		Fisher, E. H., The County Laboratory, St. Albans
Mar. 7, 1872	Trans.	Fisher, Walter William, M.A., 5, St. Margaret's-road, Oxford

Date of Election.	
April 3, 1873	Fison, Edward Herbert, Stoke House, Ipswich
April 18, 1872	Fison, Frederick William, M.A., 64, Pont-street, S.W.
Feb. 15, 1894	FitzGerald, Rev., Henry Purefoy, M.A., F.L.S., Wellington College, Berks
Dec. 3, 1896	Fleet, J. T., 24, Sheep-street, Rugby
April 16, 1874	Fletcher, Frederick W., North London Chemical Works, Holloway, N., and Beauchamp Lodge, Enfield
Dec. 3, 1885	Fletcher, Lazarus, M.A., F.R.S., Natural History Department, British Museum, Cromwell-road, S.W.
April 18, 1872	Trans. Fletcher, Thomas William, Grappenhall, Warrington
June 7, 1894	Flintoff, Robert J. Huxby, Crumpsall-lane, Crumpsall, Manchester
Feb. 18, 1892	Floris, Robert Brooke, Church-house, West Hanningfield, near Chelmsford
Dec. 5, 1895	Foakes, Jervis E., Medical School, Caxton-street, Westminster
Dec. 6, 1894	Fogg, C. A., 29, Park-road, Bolton
June 16, 1859	Fogg, Thomas, 6, Clarendon-gardens, Maida-vale, W.
Dec. 5, 1889	Foggie, John, University College, Dundee
May 7, 1885	Follows, Harold, 39, Meadow-street, Moss-side, Manchester
Feb. 21, 1853	Foord, George, Royal Mint, Melbourne, Australia
Dec. 6, 1894	Forbes, D. G., Cue, Murchison, W. Australia
Nov. 19, 1874	Forbes, James, jun., 70, Gracechurch-street, E.C.
Dec. 5, 1889	Ford, John S., care of Messrs. W. Younger and Co., Abbey Brewery, Edinburgh
Mar. 4, 1886	Formoy, James Arthur, Cheetham, Grange-road, Sutton
Dec. 7, 1893	Forrester, Alexander M., Laboratory, Port Dundas Chemical Works, 20, Canal-bank, Glasgow
Dec. 15, 1892	Trans. Forster, Dr. Martin Onslow, Royal College of Science, South Kensington, S.W.
Feb. 2, 1888	Forsyth, W. Cay, St. Andrew, 46, Queen's-road, Leytonstone
Mar. 3, 1856	Trans. Foster, G. C., F.R.S., 18, Daleham-gardens, Hampstead, N.W.
May 16, 1895	Foster, H. Irving, The Elms, Anlaby-road, Hull
April 6, 1865	Foster, Dr. M., F.R.S., Trinity College, Cambridge
April 4, 1872	Foster, Reginald Le Neve, The Firs, Clayton, Manchester
May 7, 1891	Trans. Fowler, Gilbert J., 110, Flixton-road, Urnston, Manchester
Mar. 16, 1882	Fowler, William, 1, Grace-terrace, Sunderland
Dec. 5, 1895	Fox, Stanley, 23, South-road, Faversham
June 19, 1884	Foye, Martin Hugh, M.B., C.M.,
June 21, 1877	Franchimont, A. E. N., Ph.D., Leiden, Holland
Dec. 18, 1879	Francis, Edward, Ivey Bank, Park Valley, Nottingham
Nov. 6, 1873	Francis, G. Bult, 38, Southwark-street, S.E.
Nov. 7, 1842	Trans. Francis, William, Ph.D., F.L.S., Manor-house, Richmond, Surrey, and Red Lion-court, Fleet-street, E.C.
Dec. 20, 1847	Trans. Frankland, Sir Edward, K.C.B., D.C.L., F.R.S., The Yews, Reigate-hill, Reigate

Date of Election.		
June 16, 1881		Frankland, Henry, Streonshalk, The Crescent, Linthorpe, Middlesbro'
Dec. 2, 1880	Trans.	Frankland, Percy Faraday, Ph.D., F.R.S., Mason College, Birmingham
Mar. 21, 1867		Fraser, Dr. Angus, 232, Union-street, Aberdeen
May 5, 1892		Fraser, James C., Mercantile-chas., Victoria-square, Adelaide, S.A.
May 7, 1885		Freear, Harry M., Hedgefield, Harpenden, Herts
June 16, 1887		Freeman, Frederick W., 7, Park Hall-place, East Finchley
Mar. 7, 1867		Freeman, J. Hersee, Stratford House, Stratford, E.
April 4, 1889		Freestone, Joseph T., 1, Alexander-terrace, Rock Ferry, Cheshire
Dec. 15, 1892		French, William, Highfield, 135, Walmersley-road, Bury, Lancs.
April 4, 1889	Trans.	Frew, William, Well Park Brewery, Glasgow
Feb. 2, 1871	Trans.	Friswell, R. J., 115, Darent-road, Stamford Hill, N.
Dec. 18, 1884		Frost, Joe, Moldgreen, Huddersfield
Nov. 20, 1890		Frost, Robert, 53, Victoria-road, Kensington, W.
April 15, 1880		Fryer, Alfred Cooper, Ph.D., M.A., 13, Eaton-crescent, Clifton, Bristol
May 16, 1895		Fuerst, A. F., Ph.D., 23, Marlborough-road, N.W.
Dec. 3, 1891		Fulcher, Lionel William, B.Sc., South Kensington Museum, S.W., and 56, Buckleigh road, Streatham Common, S.W.
Feb. 20, 1896		Fuller, C. J. P., Mona House, Horwich, Lancs.
Feb. 16, 1893		Feller, Frederick George, 85, Shooters-hill-road, Blackheath, S.E.
Dec. 2, 1886		Fuller, John, Rookwood, Montpelier-road, Ealing, W.
Mar. 1, 1883		Fulton, H. B., 33, St. Dunstan's-road, West Kensington, W.
May 3, 1894		Gabb, George Hugh, 43, Charlotte-street, Fitzroy-square, W.
Feb. 18, 1892		Gaillon, Alfred T., Tulloch House, Perth, N.B.
April 19, 1866		Gale, James, Ph.D., M.A., F.G.S., 169, Adelaide-road, South Hampstead
Mar. 4, 1875		Galton, Douglas, Sir, K.C.B., F.R.S., 12, Chester-street, Grosvenor-place, W., and Himbleton Manor, Droitwich
Mar. 17, 1851		Gamble, Sir David, Bart., C.B., Windlehurst, St. Helens, Lancashire
April 6, 1876		Gamble, J. C., St. Helens, Lancashire
Dec. 6, 1883	Proc.	Garbutt, Llewellyn, M.A., 10, College-street, Winchester
Mar. 15, 1888		Gardiner, James H., 59, Wroughton-road, Balham, S.W.
Feb. 21, 1895		Gardner, H. Edward, B.Sc., The College, Epsom, Surrey
May 4, 1893	Trans.	Gardner, J. Addyman, Chemical Department, Museum, Oxford
Dec. 5, 1896		Gardner, James, 80, Heaton-terrace, Rhodes, near Manchester
Nov. 15, 1888		Gardner, Walter M., Technical College, and Fairmount, Man-ningham, Bradford
May 5, 1892		Gargari, Haridas, M.A., Agra College, Agra, India
Dec. 7, 1893	Trans	Garnett, Henry, 38, Parolles-road, Upper Holloway, N.W.

Date of Election.

Jan. 17, 1889		Garrett, Frederic Chas., B.Sc., Durham College of Science, Newcastle
Jan. 20, 1876		Gaskell, Ernest Holbrook, 5, The Grove, Highgate, N.
April 17, 1884		Gaskell, Joseph, 71, Haworth-buildings, Cross-street, Manchester
Jan. 18, 1847		Gatty, F. A., Bannister Hall Works, near Preston, Lancashire
Nov. 4, 1875		Gee, T. Ernest, F.R.C.P., 67, Westbourne-park-road, W.
Mar. 3, 1887		Geisler, Joseph F., Ph.C., Mercantile Exchange Buildings, Hudson and Harrison-streets, New York
May 7, 1885		Gemmell, George Harrison, 4, Lindsay-place, Edinburgh
April 17, 1879		Gent, William Thomas, Misterton, Gainsborough
Dec. 3, 1896		George, George, Regent-street, Kingswood, near Bristol.
Feb. 21, 1889		Gerland, Conrad, M.Sc., Ph.D., Municipal Technical Laboratory, Blackburn; and Accrington
Dec. 3, 1891		German, George, Junr., Huntingdon House, Ashby-de-la-Zouch
Feb. 21, 1895		Gerrans, H. Tresawna, M.A., 20, St. John-street, Oxford
Nov. 4, 1875		Gerrard, A. W., Chertsey
Dec. 6, 1888		Geyzel, John Lawrence Van, Surgeon-Major, Chemical Examiner, Madras, East India
June 7, 1894		Ghasvala, B. E., Grant Medical College, Byculla, Bombay
Feb. 6, 1890		Gibbes, Cuthbert C., M.D., M.C., L.R.C.P. Lond., D.P.H. Cantab., F.G.S., F.L.S., 11, York-mansions, Barkston-gardens, Earls Court, S.W.
Mar. 4, 1897		Gibbons, J. L., The Higher Grade School, Blyth, Northumberland.
May 16, 1889		Gibbs, William Taylor, Masson P.O., Que., Canada, via New York
Mar. 5, 1885		Gibson, Adam, c/o Messrs. Pinkerton, Gibson & Co., Thistle-street-lane, East Edinburgh
June 16, 1892	Trans.	Gibson, John, Ph.D., F.R.S.E., F.I.C.
June 21, 1888		Gibson, W. Humphrey, 122, King's-road, Brighton
May 16, 1895		Gilbard, J. F. H., 8, Glaskin-villas, Lea Bridge-road, N.E.
May 18, 1841	Trans.	Gilbert, Sir Joseph Henry, Ph.D., F.R.S., F.L.S., Harpenden, St. Albans
Mar. 4, 1897		Gilbody, A. W., M.Sc., Ph.D., Owens College, Manchester
Feb. 1, 1883		Gill, E. Clarendon, Ivy Dene, Christchurch, Hants
Mar. 17, 1881		Gill, E. J. G., Mellikuppam, Madras Presidency, India
April 19, 1888		Gill, John, Gwealhellis, Helston, Cornwall
April 6, 1865		Gillman, A. W., 16, Sussex-square, Brighton
Dec. 3, 1885		Girdwood, Gilbert P., M.D., 54, Beaver Hall Hill, Montreal
Dec. 18, 1848	Trans.	Gladstone, John Hall, Ph.D., F.R.S., 17, Pembroke-square, Hyde Park, W.
Mar. 4, 1886		Glenfield, Francis W. S., 27, Gloucester-gardens, Hyde Park-square, W.
Jan. 18, 1872		Glover, George Thomas, Corbys, Hoylake, Cheshire
May 16, 1895		Goddard, Wm., 11, Granville-road, Middlesbro'

Date of Election.	
Feb. 21, 1895	Goldfinch, George, Hendon, N.W.
April 4, 1878	Goldschmidt, S. A., Ph.D., care of Columbia Chemical Works, 4 to 51, Sedgwick-street, Brooklyn, New York
May 16, 1889	Goldsmith, Byron B., 19, East 74th-street, New York City, U.S.A.
June 18, 1896	Goldstand, L. F., Schiffbauerdamm No. 39, Berlin
Dec. 15, 1892	Goodall, Walter, Alma House, Pudsey, near Leeds
Dec. 4, 1890	Goodwin, Thomas S., Prof., Veterinary College, Buccleuch-street, Glasgow
May 7, 1896	Goodwin, William, 4, Cowan-street, Hillhead, Glasgow
Nov. 20, 1890	Gordon, Colin, Storer's Wharf, Cubitt Town, E.
April 21, 1887	Proc. Gordon, Hugh, M.A. Oxon., The Cottage, Torkington, Cheshire
Mar. 4, 1875	Gordon, J. G., Queen Anne's Mansions, Westminster, S.W.
Mar. 6, 1890	Gossling, Frank, B.Sc., Condebec, Park Side, Hampton Wick
Feb. 1, 1883	Gothard, Frederic, Bearwood House, Burton-on-Trent
Jan. 17, 1889	Trans. Gott, B. S., B.A., Corinium, St. Mark's, Cheltenham
Feb. 6, 1879	Gough, Thomas, Rev., B.Sc. (Lond.), King Edward's School, Retford, Notts
Mar. 4, 1897	Trans. Goulding, Ernest, 18 Mercers-road, Holloway, N.
June 16, 1887	Gover, Herbert J., 29, Piccadilly, Hanley, Staffordshire
Jan. 17, 1889	Gow, Robert J., The Cedars, Hough Green, near Widnes
May 4, 1893	Gower, Alfred Roland, 18, West View-road, Barrow-in-Furness
Feb. 2, 1871	Trans. Gowland, William, 13, Russell-road, Kensington, W.
Feb. 3, 1887	Trans. Goyder, George A., Hawkins-road, Medindie, Adelaide, South Australia
June 19, 1884	Grace, W. F., 54, York-road, Hove, Brighton, and The Lake View and Boulder Junction Gold Mines, Limited, Kalgoolie, W. Australia
Feb. 15, 1894	Grafton, Walter, 54, Byron-avenue East, East Ham, Essex
April 15, 1880	Trans. Graham, C. Colborne, Highmoor, Benrhydding-road, Ilkley, Yorks
May 1, 1862	Graham, Charles, D.Sc., 23, Euston-buildings, Gower-street Station, N.W.
Dec. 5, 1895	Trans. Graham, Edward, B.Sc., The Grange, Woodlands-road, Redhill
Feb. 21, 1895	Grant, D. St. J., M.A., M.B., Lahore, India
Feb. 6, 1890	Grant, James, 9, Arthur-street, Prestwich, near Manchester
May 16, 1895	Trans. Grant, P. H., 94, Copleston-road, Denmark-hill, S.E.
June 16, 1887	Gravill, Edward D., F.R.M.S., 42, Walmsley-street, Hull
Dec. 7, 1882	Gray, George, Canterbury College, School of Agriculture, Lincoln, New Zealand
Dec. 15, 1892	Gray, Thomas, Andersonian-buildings, 204, George-street, Glasgow
Feb. 19, 1891	Greaves, Robert Bond, 77, Netheredge-road, Sheffield
May 16, 1895	Greaves, W. A., Grammar School, Newark
Dec. 4, 1890	Green, Alfred H., Oaklands, Lowton St. Mary's, Newton-le-Willows

Date of Election.

Feb. 5, 1885	Trans.	Green, Arthur George, 13, King's-drive, Heaton Moor, near Stockport
June 15, 1893		Green, Arthur Henry, 207, Lloyd-street, Greenheys, Manchester
June 16, 1887		Green, John Edward, F.I.C., A.R.S.M., 1, Queen's-road, Urms-ton, Manchester
Dec. 5, 1878		Green, Herbert, Hayle Mill, Maidstone
Dec. 5, 1878		Green, Lawrence, Lower Tovil, Maidstone
April 2, 1874	Trans.	Greenaway, Alfred John, F.I.C., 39, Frognal, Hampstead, N.W.
Dec. 3, 1885		Greene, William H., M.D., 204, North 36th-street, Philadelphia
June 4, 1885		Greenway, Thomas J., 8th Avenue, East Adelaide, South Australia
May 15, 1873		Greenwood, William Henry, Birmingham Small Arms and Metal Co., Adderley Park Works, Birmingham
Dec. 6, 1894	Proc.	Greeves, Alf., 25, Balmuir-gardens, Putney, S.W.
June 18, 1891		Gregory, Alfred John, M.D., B.Sc., Colonial Secretary's Office, Cape Town
May 7, 1885		Gregory, G. M., Ghazipur, N.W.P., India
Mar. 1, 1883		Grenfell, Claud, M.A., c/o Miss Boole, 16, Ladbroke-road, W.
Mar. 5, 1874		Greville, Henry Leicester, Diersheim, Churchfields, Woodford
Feb. 20, 1896		Grice, W. T., 9, Dalhousie-square, Calcutta
Dec. 7, 1893		Grieve, William Hatten, 226, Friern-road, East Dulwich, S.E.
Feb. 2, 1888		Griffith, D. Agnew, Ballaspet, St. John's, Isle of Man
June 16, 1859		Griffith, George, M.A., College-road, Harrow
Dec. 15, 1881	Trans.	Griffiths, Arthur Bower, Ph.D., F.R.S.E., 12, Knowle-road, Brixton, S.E.
April 17, 1879		Griffiths, Thomas, The Cedars, Clapham Common, S.W.
Feb. 21, 1895		Grime, Herbert, 11, Church-rd., Chorlton-cum-Hardy, Manchester
Feb. 19, 1874	Trans.	Grimshaw, Harry, Sunnyside, North-road, Clayton, Manchester
April 15, 1880		Grimwood, Robert, London County Council, Chemical and Gas Department, 40, Craven-street, W.C.
May 4, 1893		Grimwood, Robert George, 41, Lady Margaret-road, St. John's College Park, N.W.
Dec. 5, 1889		Gripper, Harold, 2, Heald-place, Rusholme, Manchester
Dec. 15, 1892		Gronow, William Thomas, Port Pirie Smelting Works, Port Pirie, South Australia
Dec. 5, 1895		Grossman, E. H., 12, Alfred-place West, S.W.
April 6, 1871	Trans.	Groves, Charles Edward, F.R.S., Kennington-green, S.E., and Guy's Hospital, S.E.
Mar. 4, 1897		Guest, E. G., M.A., The Grammar School, Kirkham, Lanes.
June 7, 1888		Guiterman, Albert L., Ph.D., 36, Primrose Hill-road, N.W.
May 16, 1895		Gunn, A., c/o Messrs. Fletcher, Fletcher, and Co., manufacturing chemists, Holloway, N.
Dec. 6, 1888	Trans.	Guthrie, Frederick Bickell, Chemical Laboratory, The University, New South Wales
Nov. 4, 1875		Guyer, James Brett, Wrentham, Higher Erith-road, Torquay

Date of Election.		
June 4, 1874		Habirshaw, W. M., Glenwood Works, Yonkers, New York, U.S.A.
Feb. 7, 1878		Hadkinson, John
June 7, 1884		Hadley, Arthur, United Breweries, Carmarthen
Dec. 7, 1893		Hadley, Henry Edwin, The School of Science, Kidderminster
Dec. 16, 1886	Trans.	Haga, T., Kantstrasse 24 ^m , Charlottenberg, bei Berlin
June 16, 1881		Hailes, Alfred James de, 15, Red Lion-square, W.C.
Dec. 15, 1892		Haines, Walter S., Prof., c/o Rush Med. College, Chicago, U.S.A.
Jan. 20, 1876	Trans.	Hake, H. Wilson, Ph.D., Westminster Hospital, S.W.
Dec. 7, 1893		Hale, Henry Ormsby, Oundle School, Northamptonshire
Dec. 3, 1891		Hall, A. D., S.E., Agricultural College, Wye, Kent
Jan. 17, 1889		Hall, Allan T., Ivy Cottage, Willerby, near Hull
Dec. 3, 1891		Hall, Archibald, 34, Bishopsgate-street, E.C.
April 4, 1889		Hall, Rev. James, B.A., B.Sc., Baneroff's School, Woodford, Essex
Jan. 17, 1889	Trans.	Hall, John A., Victoria Chemical Works, Victoria, B.C.
June 1, 1876		Hall, Samuel, East London Soap Works, Bow
Dec. 18, 1884		Hall, Thomas P., M.A., Ph.D., Tabor, Iowa, U.S.A.
Feb. 16, 1893		Haller, Albin, 14, Rue de Metz, Nancy, France
May 16, 1895		Haller, H. L., 109, Tennyson-place, Bradford
May 20, 1886		Halliburton, William Dobinson, M.D. Lond., B.Sc. Lond., F.R.S., 9, Ridgmount-gardens, Gower-street, W.C.
Feb. 3, 1859		Hambly, C. H. Burbidge, "Fairley," Weston, Bath
April 17, 1890	Trans.	Hambly, Frederick J., Gordon's College, Aberdeen
June 7, 1888	Trans.	Hamilton, James C., Arncliffe, Arnside, viâ Carnforth
Feb. 15, 1894		Hamilton, Robert, Leeds Steel Works, Leeds
May 6, 1875	Trans.	Hamlet, W. M., Government Laboratory, Macquarie-street, Sydney, N.S.W.
Dec. 7, 1882		Hammersley, W. A. Leslie, Bridge House, Leek, Staff.
Jan. 18, 1877		Hampton, William, 38, Lichfield-street, Hanley
Feb. 7, 1857		Hanbury, Cornelius, Plough-court, Lombard-street, E.C., and Dynevor House, Richmond, Surrey
June 15, 1893		Hancock, Ernest Albert, Government Analyst, St. Kitts, Leeward Islands, W.I.
Dec. 5, 1895	Trans.	Hanes, E. S., 108, Alexandra-road, N.W.
June 18, 1896		Hanger, R.H., Rivers-lea, Stoneferry, Hull
Mar. 7, 1872	Trans.	Hannay, James Ballantine, Cove Castle, Loch Long, N.B., and Whitehall Club, S.W.
Feb. 21, 1889		Hanson, Alfred Miall, The Marjorie, Whalley, near Blackburn
Feb. 21, 1895		Hanson, Weldon, 30, Baker-street, Middlesbrough
Feb. 3, 1859	Trans.	Harcourt, A. G. Vernon, M.A., D.C.L., LL.D., F.R.S., Cowley Grange, Oxford

Date of Election.

April 16, 1863		Harcourt, L. F. Vernon, M.A., Fairholme, Weybridge
Mar. 17, 1887	Proc.	Harden, Arthur, Ashville, Upper Chorlton-road, Manchester
May 7, 1885		Hards, William Benjamin, B.A. Lond., Science and Art Department, South Kensington, S.W.
Dec. 15, 1892		Hardy, James G., 5, Dalkeith Avenue, Dumbreck, Glasgow
Jan. 20, 1876		Hargreaves, James, Peel House-lane, Farnworth, near Widnes, Lancashire
June 19, 1884		Hargreaves, John, Widnes, Lancashire
Dec. 16, 1875		Harkness, William, 1, St. Mary's-road, Canonbury, N.
June 1, 1876		Harland, R. H., 37, Lombard-street, E.C.
Feb. 7, 1878		Harland, William Dugdale, 48, King-street, Manchester
Mar. 4, 1897		Harley, Vaughan, M.D., 25, Harley-street, W.
Jan. 15, 1874		Harman, F. E., M.R.A.C., c/o Dr. Piggott, 13, Orchard-gardens, Teignmouth, Devon
Dec. 15, 1881		Harrington, William Bury, Leevew, Montenotte, Cork
Feb. 20, 1896		Harrington, Wm., 9, Edgehill, Bransby, Whitehaven
June 18, 1896		Harris, F. W., Public Analyst's Office, Burnley
Feb. 21, 1884		Harris, Frank W., Laboratory, G.W. Ry., Swindon, Wilts
Dec. 7, 1893		Harris, Harold, 2, Connaught-buildings, Wotton-without, Gloucestershire
Feb. 21, 1895		Harris, Harry, Clarendon, Mundania-road, Honor Oak, S.E.
Dec. 17, 1874		Harris, Henry Penley, 15, Coverdale-road, Shepherd's Bush, W.
June 7, 1894		Harris, Sydney Walters, 15, Lansdowne-terrace, Walters road, Swansea
Feb. 7, 1878		Harris, Thomas Frederick, B.Sc., Bromley Lodge, Bromley, Kent
Feb. 21, 1895		Harris, Walter, B.A., Ph.D., Campbell College, Belfast
May 17, 1888		Harrison, Albert, 72, Windsor-road, Forest Gate
Dec. 5, 1893		Harrison, C. E., B.A., Abbey View, Potters-bar, N., and St. George's-house, Eastcheap
Feb. 15, 1894	Trans.	Harrison, Edward Frank, 51, Holly-avenue, Newcastle
June 21, 1883		Harrison, Hugh Erat, B.Sc., 2, Park-place, Regent's Park, N.W. and Faraday House, Charing Cross-road
May 17, 1888		Harrison, J. Burchmere, Government Laboratory, British Guiana
Feb. 19, 1891		Harrold, Frederick W., 18, Maddox-street, W.
Feb. 17, 1876	Trans.	Harrow, G. H., Ph.D., Messrs. Allsopp and Sons' Brewery, Burton-on-Trent
Mar. 4, 1886		Hart, Bertram Harvey, The Elms, Old Charlton, Kent, S.E.
Jan. 21, 1869	Trans.	Hart, F. W., Holly House, 96, Stoke Newington-road, N.
May 7, 1891		Hart, William Beaumont, Gransmoor Avenue, Fairfield, near Manchester
Mar. 16, 1882		Hartley, Arthur, The Haslar-street Brewery, Gosport
Mar. 4, 1897		Hartley, E. G. J., B.A., Wheaton-Aston Hall, Stafford
Mar. 4, 1897		Hartley, Thomas, Patwell-street, Bruton, Somerset

Date of Election.		
Dec. 20, 1866	Trans.	Hartley, Walter Noel, Prof., F.R.S., Royal College of Science, Stephen's-green, Dublin; and 36, Waterloo-road, Dublin
Feb. 6, 1890	Proc.	Hartog, P. J., B.Sc., Owens College, Manchester
Dec. 3, 1885		Harvey, Ernest Wm., A.R.S.M., 20, Malwood-road, Balham, S.W.
Feb. 17, 1881		Harvey, Sidney, Canterbury
Feb. 15, 1894		Harvey, W. Pellew, Assay and Mining Office, Vancouver, B.C.
May 6, 1875		Hastings, Henry Mitchell, 54, Edith-road, The Cedars, West Kensington
Feb. 21, 1894		Hatfield, J. Adams, 89, Bridge-street, Wednesbury
Feb. 18, 1892		Hatton, William Percy, care of W. R. Hatton and Sons, Wormwood Scrubs
Dec. 2, 1880		Hawkes, Alfred E., M.D. Bruss., J.R.C.P. Edin., 22, Abercromby-square, Liverpool
May 7, 1896		Hawkins, Edgar, M.D., M.A., M.S., Dispensary, Dudley
Feb. 2, 1888		Hawkins, Lewis Walter, 20, Norton Folgate, E.
Dec. 6, 1894	Trans.	Haworth, E., B.Sc., Hyndburn-bridge, Clayton-le-Moors. Accrington
Mar. 3, 1887		Hay, Alexander, 17, Percival-street, Manchester
Feb. 15, 1894		Hayward, Edward Stanley, c/o Mrs. Sauders, 109, High-street, Crediton, Devon
Dec. 1, 1887		Head, C. James, F.I.C., 104, Leadenhall-street, E.C.
Dec. 15, 1881		Head, Harold Elmershaw, 5, Ilchester-mansions, Kensington, W.
Mar. 16, 1876		Head, Jeremiah, 47, Victoria-street, Westminster, S.W.
Feb. 16, 1893		Heath, Arthur John, 1, Grove-villas, Redland, Bristol, and Monkton Combe School, Bath
Dec. 3, 1891		Heath, John William, 33, Upper Gloucester-place, W.
Nov. 2, 1876		Hehner, Otto, 11, Billiter-square, E.C.
Dec. 5, 1889		Helbing, H. B., 63, Queen Victoria-street, E.C.
Dec. 4, 1890	Proc.	Heller, William M., B.Sc., 59, Ickburgh-street, Clapton, N.E.
June 3, 1875		Hellon, Robert, Ph.D., Seascale, viâ Carnforth
Jan. 18, 1872		Helm, Henry James, Simonstone, Hammelton-road, Bromley, Kent
Dec. 6, 1894		Helms, Albert, M.A., Ph.D., 8, Bridge-street, Sydney, N.S.W.
Feb. 20, 1896		Helps, J. W., 3, Tavi-tock-road, Croydon
Feb. 5, 1885	Trans.	Henderson, George G., Prof., M.A., D.Sc., F.I.C., the Technical College, 204, George-street, Glasgow
Dec. 5, 1895	Trans.	Henderson, James, care of Prof. Dr. Lintner, Polytechnicum München
Feb. 18, 1892		Hendrick, James, B.Sc., F.I.C., The University, Aberdeen
Feb. 21, 1853		Hepburn, J. G., LL.B., Dartford, Kent
Mar. 4, 1897		Heppenstall, Charles, Victoria-road, Stanford-le-Hope, Essex
June 18, 1885		Hepworth, T. Cradock, 10, Lysias-road, Balham-hill, S.W.
Dec. 5, 1895		Heriot, T. H, P., 23, Wolesey-road, Crouch End, N.
Feb. 16, 1871		Herman, Douglas, Eccleston-park, Prescott
June 15, 1876	Trans.	Heron, John, 110, Fenchurch-street, E.C.

Date of Election.

Dec. 7, 1893		Hesketh, William, 16, New Market-street, Blackburn
May 5, 1892	Trans.	Hewitt, John Theodore, M.A., D.Sc., Ph.D., People's Palace Technical Schools, E.
Feb. 18, 1892		Hewlett, John C., 40, Charlotte-street, Great Eastern-street, London, E.C.
June 21, 1883	Trans.	Heycock, Charles T., M.A., F.R.S., 24, Fitzwilliam-st., Cambridge
Dec. 1, 1864		Heywood, Henry, Witla Court, near Cardiff
Dec. 1, 1887		Heywood, J. Garnett, 127, Sutherland-avenue, Maida Vale, W.
Feb. 6, 1890		Heywood, Joseph H., Sparth Cottage, Manchester-road, Roch- dale
April 3, 1848		Heywood, J. S. C., 19, Inverness-terrace, Kensington-gardens, W.
June 1, 1876	Trans.	Hibbert, Walter, 101, Goldhurst-terrace East, South Hampstead, N.W.
June 7, 1894		Hichens, J. H., M.A., F.G.S., The School House, Wolverhampton
Mar. 17, 1881		Hiddingh, Michael, Newlands, near Capetown
May 7, 1891		Hiepe, William L., Ph.D., The Laboratory, Kilvert's Buildings, Withy Grove, Manchester
Dec. 6, 1894		Higgs, M. S., Eastleigh Gold Mines, Klerksdorp, S.A.R.
March 16, 1882		Hill, Alexander
Dec. 16, 1858		Hill, Alfred, M.D., F.I.C., F.R.S.E., Medical Officer of Health, The Council House, Birmingham
Dec. 3, 1896		Hill, A. Croft, B.A., Trinity College, Cambridge
Dec. 3, 1896		Hill, C. A., Hawthorns, South-road, Clapham Park
June 18, 1896		Hill, E. G., Prof., B.A., Muir College, Allahabad
Feb. 21, 1895		Hill, E. H.
May 6, 1897		Hill, Sydney, 11, Salisbury-street, Hull
Feb. 15, 1894		Hills, Edmond Herbert, Capt. R.E., Darland House, Chatham
Mar. 5, 1892		Hills, Harold F., Pine Island P.O., Kent, Auckland, N.Z.
May 15, 1873		Hills, Walter, 225, Oxford-street, W.
Dec. 3, 1896		Hineley, J. W., 64, Park Walk, Chelsea, S.W.
May 5, 1892		Hinnell, Henry Leonard, 41, Corporation-street, Manchester.
May 3, 1894		Hirsch, C. T. W., M.D., Government Medical Officer, Fiji
Jan. 20, 1870		Hislop, G. R., Gasworks, Blackstoun-road, Paisley
Nov. 18, 1886		Hislop, Lawrence, 33, Slaty-road, Birkenhead
June 21, 1883		Hobbs, Bedo, The Brewery, High-street, Maidenhead
Dec. 18, 1884		Hodges, Herbert J., Dagmar, Napier-avenue, Fulham
April 15, 1844	Trans.	Hodges, John F., Prof., M.D., F.I.C., J.P., Queen's College, Belfast, and Sandringham, Malone-road, Belfast
Nov. 16, 1882	Trans.	Hodgkin, John, F.L.S., F.I.C., 12, Dynevor-road, Richmond- on-Thames
Dec. 18, 1879	Trans.	Hodgkinson, W. R. Eaton, Prof., Ph.D., F.R.S.E., 8, Park, villas, Blackheath, S.E.
April 15, 1886		Hodgson, Christopher, High House, Eppleby, Darlington
April 17, 1873		Hodgson, H. Tylston, Harpenden, Herts

Date of Election.		
Dec. 6, 1894		Hogg, A. F., M.A., 4, Cliffe-terrace, Woodland's-road, Darlington
May 7, 1885		Hogg, Edward Grindle, 1, Southwick-street, Hyde Park-square, W.
Mar. 1, 1883		Hogg, W. Douglas, M.D., 62, Champs Elysées, Paris
June 11, 1876		Holcroft, Harold, M.A., Parkdale, Wolverhampton
Dec. 3, 1885		Holgate, Thomas, 12, Hyde Park-road, Halifax
Mar. 16, 1876		Holland, Philip, 22, Taviton-street, Gordon-square
Dec. 2, 1880		Holliday, Robert, c/o Messrs. Read, Holliday and Sons, Limited, Huddersfield
June 18, 1891		Holloman, Frederick R., c/o Messrs. Tennant's Agency, San Fernando, Trinidad, B.W.I.
Mar. 4, 1886		Holloway, George Thomas, 57 and 58, Chancery-lane, W.C.
Dec. 5, 1895		Holme, A. E., M.A., 3, Ash-terrace, Saville Town, Dewsbury
Mar. 4, 1897		Holmes, John, Crewe Villa, Putney Bridge-road, S.W.
Dec. 2, 1886		Holmes, John Winder, Rayton-xi-towns, Shropshire
Dec. 7, 1893		Holthouse, H. B., 42, St. Ann's-valley, Nottingham
May 4, 1865		Holzmann, M., Ph.D., Marlborough-house, S.W.
Feb. 7, 1873		Hooker, A. H., Board of Health, Cairo, Egypt
Dec. 15, 1892	Trans.	Hooker, Samuel C., The Franklin Sugar Refinery Co., 701, Front-street, Philadelphia
Mar. 1, 1883		Hooper, David, Curator, Economic and Art Section, Indian Museum, Calcutta
May 17, 1888		Hooper, E. Grant, 16, Royal-avenue, Chelsea, S.W.
Feb. 19, 1891		Hooper, Ernest F., Wear Fuel Works, Hendon Dock, Sunderland
Feb. 15, 1894		Horuby, R., B.A., The High School, Newcastle, Staffordshire
Dec. 15, 1892		Horsfall, John, 4, Grange-avenue, Rawtenstall, Manchester
Dec. 15, 1892		Horwill, Edgar E. C., Firs Villa, Fitzwilliam-road, Clapham, S.W.
Mar. 4, 1886		Hoskins, Arthur Percy, 25, Cromwell-road, Belfast
Dec. 7, 1882		Hotblack, Herbert A., Cannon Brewery, Brighton
Feb. 16, 1871		Houlder, W. W., 10, Ossulton-villas, Southall-green, Southall
Mar. 17, 1887	Proc.	Houlding, William, B.Sc., 26, Huskisson-street, Liverpool
Feb. 20, 1896		Howard, Albert, A, New-court, St. John's College, Cambridge
Dec. 7, 1882		Howard, Alfred G., Burnt House, Chigwell, Essex
Feb. 18, 1869		Howard, Alfred Kingsby, Bryntirion, Rhyl, N. Wales
Nov. 3, 1870	Trans.	Howard, David, Devon House, Buckhurst Hill, Essex
April 21, 1887		Howard, D. Lloyd, jun., Alton Lodge, Woodford-green, Essex
June 20, 1889		Howard, George William, Calverley, Tanbridge Wells
Mar. 4, 1875		Howard, Thomas, 50, Ellington-street, Liverpool-road, N.
Dec. 7, 1882		Howe, J. Lewis, M.D., Ph.D., Prof. of Chem., Washington, and Lee University, Lexington, Va., U.S.A.
Feb. 19, 1880		Howell, Reginald, 95A, Southwark-street, S.E.
Jan. 20, 1876		Howie, W. L., Monton Lodge, Monton, Eccles, Lancashire
April 4, 1889		Hoyle, Richard Ashworth, 11, Market-square, Lytham, Lanes.
April 4, 1889		Hoyles, Henry Richardson, c/o Messrs. Treacher and Co., Byculla Bombay, and Fern-place, 112, Upperthorpe, Sheffield

Date of Election.

Mar. 2, 1871		Hudleston, W. H., M.A., F.G.S., 8, Stanhope Gardens, South Kensington, S.W.
Feb. 21, 1895		Hudson, Percy, 48, Alexandra-road, Burton-on-Trent
Feb. 21, 1878		Hudson, William, B.Sc. (Lond.), The Lilies, Twickenham
Feb. 15, 1894	Trans.	Hughes, Frank, 78, Duke-street, Chelmsford
June 17, 1880		Hughes, George Henry, Analytical Laboratory, Barbadoes, West Indies; and 155, Fenchurch-street, E.C.
Dec. 17, 1868		Hughes, John, Analytical Laboratory, 79, Mark-lane, E.C.
June 18, 1896		Hughes, J. A., 1, Bridewell-street, Bristol
Dec. 5, 1889	Trans.	Hughes, Robert Edward, M.A., B.Sc., Tanbryn, Cefn Coed, Merthyr Tydfil, and Education Department, Whitehall, S.W.
June 4, 1885		Hughes, T. Vaughan, Princes Chambers, 6, Corporation-street, Birmingham
Nov. 16, 1882		Hughes, Thomas, Borough Analyst, West Wharf, Cardiff Laboratory, 31, London-square, Cardiff
Nov. 20, 1884		Hulme, James, Newton Chemical Works. Hyde, Manchester
April 19, 1883		Humphrys, Norton H., 4, The Paragon, Wilton-road, Salisbury
Dec. 18, 1879	Trans.	Hummel, J. J., The Yorkshire College, Leeds
Dec. 7, 1893		Hunt, Bertram, 216, Sansome-street, San Francisco, California, U.S.A.
Mar. 18, 1869		Hunt, Charles, Birmingham Gas Light Works, Windsor-street, Birmingham
Feb. 1, 1883		Hunter, John, 29, Chambers-street, Edinburgh
Dec. 3, 1885		Hunter, Matthew, M.A. Oxon, Rangoon College, Lower Burmah
April 4, 1878		Huntington, A. K., Prof., Metallurgical Laboratory, King's College, W.C.
Feb. 16, 1893		Huntly, George Nevill, 56, Sheen-road, Richmond
Dec. 3, 1885		Hurst, George H., 22, Blackfriars-street, Salford
Mar. 21, 1861		Huskisson, H. O., 5, Gordon-square, London, W.C.
Feb. 15, 1894		Hutchinson, Alfred, B.A., B.Sc., Bryn-y-Mer, Saltburn
Feb. 6, 1890	Trans.	Hutchinson, Arthur M.A., Ph.D., Pembroke College, Cambridge
Jan. 17, 1884		Hutchinson, C. Clark, Barrister-at-Law, 3, Harcourt-buildings, Temple, W.C.
Nov. 19, 1885		Hyatt, H., 1, Milton-road, Herne Hill, S.E.
Mar. 4, 1897		Ibbotson, F., B.Sc., 9, Melbourn-road, Spring-vale, Sheffield
April 19, 1888		Idris, Thomas Howell Williams, Pratt-street, Camden Town, N.W.
Feb. 7, 1867		Ince, Joseph, 11, St. Stephen's-avenue, Shepherd's-bush, W.
Dec. 15, 1892	Trans.	Ince, Walter H., Ph.D., Port of Spain, Trinidad
April 4, 1889		Ingle, Herbert, Poole, near Leeds
Mar. 4, 1897		Innes, W. R., Ph.D., B.Sc., Mason College, Birmingham
Mar. 4, 1897	Trans.	Irvine, Robert, Royston, Granton, near Edinburgh

Date of Election.

Dec. 6, 1883		Irwin, Wilfred, 3, Wilton Polygon, Cheetham Hill, Manchester
Dec. 15, 1892		Isaac, John F. V., Royal York Hotel, Brighton
Feb. 16, 1882		Isherwood, Thomas, B.A., LL.B., University School, Southport
Nov. 19, 1885		Ivatt, Albert, B.A., 38, Glisson-road, Cambridge
May 3, 1894		Jackman, Edwin James, 60, Belgrave-road, Ilford
Feb. 1, 1883		Jackson, A. H., B.Sc., The Electrical Engineering School, 353, Collins-street, Melbourne, Australia
Feb. 15, 1894	Proc.	Jackson, David Hamilton, M.A., B.Sc., Ph.D., Scientific Department, Imperial Institute, S.W.
Dec. 7, 1882		Jackson, Edward, 27, Beaufort-road, Edgbaston, Birmingham
Dec. 5, 1889		Jackson, Eric H., B.Sc., Harsfield, Morley-road, Southport
Dec. 18, 1884	Trans.	Jackson, Herbert, 3, Amyand Park Gardens, East Twickenham, and King's College, Strand
Dec. 15, 1892		Jackson, John, Llangorse Villa, Serpentine-road, Gold Tops, Newport, Mon.
Dec. 6, 1883		Jackson, Robert, 18, Harrington-street, Dublin
Dec. 15, 1881		Jackson, R. Valentine, c/o The Scotch and Irish Oxygen Company, Polmadie, Glasgow
Dec. 15, 1892		Jackson, Samuel, c/o Binney and Co., Madras
June 16, 1887		Jadhava, K. B., Nowasari, Bombay Presidency, India
May 16, 1878	Tra ns.	Jago, William, F.I.C., Godrevy-house, Wilbury-avenue, Hove, Brighton, and Cornwall-buildings, 35, Queen Victoria-street, E.C.
Dec. 5, 1895		James, Alfred, 56, New Broad-street, E.C.
Feb. 18, 1888		James, Christopher, care of Elliott's Metal Company, Pembrey Copper Works, R.S.O., Burry Port, South Wales
Feb. 17, 1881	Trans.	James, J. William, Ph.D., 29, Redcliffe-street, Bristol
Feb. 7, 1878		Jamieson, Alexander, 5, St. Mark's-crescent, Regent's Park N.W.
Feb. 6, 1879	Trans.	† Japp, F. R., M.A., LL.D., Ph.D., F.R.S., University, Aberdeen
Feb. 15, 1894		Jardine, Walter, 7, Rockford-terrace, Jeanfield, Perth
Nov. 16, 1882		J'armay, Gustav, Hartford Lodge, Hartford, Cheshire
Feb. 20, 1896		Jeffers, E. H., 21, Moatholme-road, New Wandsworth, S.W.
Feb. 19, 1891		Jenkins, Henry Charles, Royal Coll. of Science, S. Kensington, S.W.
May 5, 1892		Jenkins, John H. B., Chemical Laboratory, G.E. Ry. Works, Stratford, E.
May 7, 1896		Jenkins, J. P., 30, St. John's-road, Clifton, Bristol
Feb. 15, 1894		Jenks, R. Leonard, 33, Cautley-avenue, Clapham Common S.W.
Feb. 15, 1894		Jennison, Francis Herbert, Hollywell House, Theaker-lane, Armley, near Leeds

† Longstaff Medallist, 1891.

Date of Election.

Mar. 4, 1896	Trans.	Jerdan, D. S., M.A., B.Sc., Grabengasse, 9, Heidelberg
April 17, 1879		Jewson, Francis A. B., Homefield, Station-road, Clapham
Feb. 4, 1875		Johnson, David, F.G.S., F.R.M.S., 1, Victoria-road, Clapham Common, S.W.
Dec. 5, 1895		Johnson, F. E., 16, Stan'ey-terrace, Anlaby-road, Hull
Mar. 4, 1897		Johnson, Harold, 5, Boulevard Clovis, Bruxelles.
Feb. 1, 1883		Johnson, James Edward, 40, Edmiston-road, Stratford, E.
May 16, 1872		Johnson, John Grove, 41, Cross-street, Finsbury, E.C.
May 20, 1886		Johnson, J. T., 55, South-street, Durham
Mar. 4, 1897		Johnson, Otis C., Prof., 52, Thayer-street, Ann Arbor, Mich. U.S.A.
May 10, 1866		Johnson, Samuel H., The Warren Hill, Loughton, Essex
Feb. 20, 1896		Johnstone, James, Braehead, Parkhill, Rutherglen
Dec. 18, 1884		Johnstone, James D., 9, Orange-lane, Montrose
Dec. 15, 1892		Johnstone, William George, c/o Messrs. Warwick's, The Brewery, Newark-on-Trent
May 20, 1886	Proc.	Jones, A. Wentworth, M.A. Oxon, M.R.C.S., L.R.C.P., Headmaster Paddington High School, W., and 7, St. Charles-square, W.
May 16, 1895		Jones, E. L., 4, Bank-buildings, Llandilo
April 6, 1871	Trans.	Jones, E. W. T., The Oaklands, Wolverhampton; and 10, Victoria-street, Wolverhampton
Dec. 4, 1873	Trans.	Jones, Francis, F.R.S.E., Beaufort House, Alexandra Park, Manchester
Dec. 6, 1894		Jones, Geo. Cecil, Basingstoke Ironworks, Hants
May 4, 1876	Trans.	Jones, H. Chapman, Royal Coll. of Science, S. Kensington, S.W.
May 4, 1893		Jones, Hedley Gordon
May 16, 1878		Jones, Henry Williams, Spencer-park, Coventry
May 15, 1890		Jones, John Archyll, B.Sc., 27, Southfield-road, Middlesborough
Feb. 18, 1892	Trans.	Jones, Lionel Manfred, St. Dunstan's College, Catford, S.E.
Feb. 19, 1891		Jones, M. William, 433, Stretford-road, Old Trafford, Manchester
May 7, 1896		Jones, R. H., 55, Eldon-street, Newcastle-on-Tyne
Feb. 21, 1895		Joseph, Edgar, 42, Brondesbury-road, Kilburn, N.W.
May 4, 1893	Trans.	Jowett, Hooper A. D., D.Sc., 20, Kilmorrie-road, Forest-hill, S.E.
Feb. 21, 1891		Jowett, William Hall, 2, Mayfield-road, Aigburth, near Liverpool
May 4, 1893		Kaká Sorabji, Manekji, Devon Villa, Karachi, Sind, India
Dec. 16, 1886	Trans.	Kawakita, Michitada, Engineering College, Tokio, Japan
Feb. 17, 1881	Trans.	Kay, William E., 47, Camphill-street, Queen's-park, Glasgow
Dec. 20, 1883		Keeling, Frank, 190, Lake-avenue, Rochester, N.Y., U.S.A.
Dec. 7, 1882		Keen, Austin, 13, Lyndewoode-road, Cambridge
May 3, 1894		Kellas, Alex. Mitchell, 24, Cecile-park, Crouch-hill, N.

Date of Election.

Mar. 19, 1874		Kellner, William, Ph.D., Chemical Department, Royal Arsenal Woolwich, S.E.
April 4, 1867		Kemp, David Skinner, 52, Coverdale-road, Shepherd's Bush, W.
May 4, 1882		Kemp, William Joel, Mountfield, Robertsbridge, Sussex
Dec. 18, 1884		Kendall, George Frederic, B.A., The Hollies, Stratford-upon-Avon
Dec. 17, 1874		Kendall, James Alfred, Lonesome Chemical Works, Streatham Common, S.W.
Feb. 20, 1896		Kennicott, C. L., 4,050, Ellis-avenue, Chicago, Ill., U.S.A.
Dec. 5, 1889		Kenwood, Henry R., M.B., C.M. (Edin.), L.R.C.P. (Lond.), 9, Alexandra-villas, Finsbury Park, N.
Feb. 21, 1895		Kenyon, Rich. E., B.Sc., 124, Wilderspool-road, Warrington, Lancs.
Dec. 20, 1883		Kerry, William H. R., Wheatlands, Windermere
Dec. 5, 1895		Kibble, W. O., G.P.O., Auckland, N.Z.
Dec. 7, 1882		Kilner, Frederick James, Royal Infirmary, Bristol
Jan. 17, 1884		Kilpatrick, W. Stirling, 4, Annfield-place, Glasgow
Feb. 15, 1872	Trans.	Kinch, Edward, Royal Agricultural College, Cirencester
Feb. 17, 1881	Trans.	King, Alfred John, Ingersley Vale, Bollington, near Macclesfield
Mar. 4, 1897		King, Herbert, B.Sc., 4, North-street, Scarborough
Dec. 7, 1876		King, J. F., Laboratory of City Analyst, Edinburgh
Feb. 21, 1895		Kingdon, G. Holman, B.A., c/o Messrs. Crosfield, Limited Warrington
Dec. 5, 1872	Trans.	Kingzett, Charles T., Elmstead Knoll, Chislehurst, Kent
Dec. 5, 1895		Kinnicut, Prof. L. P., Worcester, Mass., U.S.A.
Mar. 1, 1877		Kinnimont, Alex., Whitehall, Bothwell, N.B.
May 7, 1891	Trans.	Kipping, F. Stanley, Ph.D., D.Sc., F.R.S., 7, Milborne-grove South Kensington
Dec. 2, 1886		Kirby, Herbert E., 307, High Holborn, W.C.
May 15, 1890		Kirk, Oliver, 19, Carlton-road, Workington
Feb. 21, 1895		Kirkaldy, Patrick H., 19, Clifton-road, Crouch End, N.
June 19, 1873		Kitchin, Archibald, F.I.C., Seragill House, Whitehaven
May 16, 1889		Kitchin, John, The Middlesex Hospital, W.C.
Dec. 6, 1888		Knaggs, Alfred Battye, 2, Bradley-lane, Huddersfield
June 20, 1889		Knight, Frederick Charles, Boston and Colorado Smelting Company, Argo, Colorado, U.S.A.
Dec. 6, 1894		Knight, James, M.A., B.Sc., John-st. School, Bridgeton, Glasgow
June 18, 1896		Knight, J. B., Bushwood, Wanstead, Essex
May 3, 1894		Knight, Wm. Albt., Sexey's Trade School, Bruton, Somerset
May 16, 1878		Knights, James West, County Laboratory, Cambridge
Dec. 18, 1879		Knowles, Joshua, Stormer-bill, Tottington, Bury
Dec. 15, 1892		Knowles, Thomas Torrens, 27, Peel-street, Princes Park, Liverpool

Date of Election.

June 16, 1864		Knox, G. W., B.Sc., 16, Finsbury-circus, London, E.C.
Feb. 6, 1873		Koch, Walter Edward, M.A., F.G.S., Sharpsburg, Allegheny Cy., Pa.
Nov. 17, 1887	Trans.	Koga, Yoshimasa, The Imperial Mint, Osaka, Japan
June 17, 1886	Trans.	Kohn, Charles A., Ph.D., B.Sc., 20 Mulgrave-street, Liverpool
June 8, 1885		Koningh, Leonard de, 325, Kennington-road, S.E.
Dec. 15, 1892		Krause, Dr. G., Cothen, Germany
Feb. 17, 1859	Trans.	Kynaston, Josiah W., Chemical Laboratory, 3, Oak-terrace, Beech-street, Liverpool
Dec. 6, 1894		Ladeil, R. S., 67, Church-road, Tranmere, Birkenhead
Feb. 3, 1859		Lackersteen, Mark Henry, M.D., M.R.C.P. Lond., M.R.C.S. Eng., F.L.S., The Reliance Buildings, 100, State-street, Chicago, U.S.A.
Feb. 16, 1888		Lafosse, Charles R., Abbotsford, Wildercombe Park, Ilfracombe
May 4, 1893		Lamb, Edmund George, M.A., Old Lodge, Salisbury
Dec. 15, 1892	Trans.	Lamb, Thornton Charles, The Polygon, Ardwick, Manchester
Feb. 16, 1893		Lambert, Wesley J., Moda, Constantinople, Turkey
Jan. 18, 1877		Lancaster, William James, F.R.A.S., F.R.C.S., F.R.M.S., The Hollies, Handsworth Wood, Birmingham
Mar. 4, 1886		Lang, William, Cross Bank, Partick
Mar. 4, 1897		Lang, W. R., B.Sc., 9, Crown-gardens, Glasgow
June 18, 1885		Langer, Charles, Ph.D., Hampton House, Milverton-terrace, Leamington, Spa
May 7, 1891		Langham, Rev. E. Norman, M.A. (Cantab), F.L.S., Head Master, Rastrick Grammar School, Brighouse
Feb. 16, 1894	Trans.	Lapworth, Arthur, D.Sc., 17, Bloomsbury-square, W.C.
June 21, 1883		Lascelles, B. P., B.A., Harrow
April 15, 1880		Last, Frank B., Laboratory, 78, Mansell-terrace, Swansea
May 7, 1891	Trans.	Lauder, Alexander, The Hartley Institute, Southampton
Mar. 4, 1886	Trans.	Laurie, Arthur P., Woodside, Baldwin Hill, Loughton
Nov. 16, 1876		Law, Channell, Ilsham Dene, Torquay
May 7, 1896		Law, H. E., 1,526, Vallego-street, San Francisco, Cal., U.S.A.
Feb. 6, 1890	Trans.	Law, Robert, F.R.M.S., F.I.C., The Royal Mint, Melbourne
June 17, 1850	Trans.	Lawes, Sir John Bennet, F.R.S., Rothamsted, near St. Albans
June 17, 1880	Trans.	Lawrance, Henry Awbrey, Avondale House, Bree-street, Cape Town
Dec. 3, 1896	Trans.	Lawrence, W. T., B.A., Ph.D., 57, Prince's Gate, S.W.
Jan. 19, 1882		Laws, J. Parry, F.I.C., Westfield, Bath-road, Worcester
Feb. 2, 1888	Trans.	Lawson, Thomas Atkinson, Ph.D., B.Sc., 114, Alexandra-road, N.W.
April 17, 1890	Trans.	Laycock, William Frederick, Ph.D., 2, Park-street, Dewsbury
April 17, 1890		Lea, A. Sheridan, D.Sc., F.R.S., Caius College Cambridge
Dec. 16, 1886		Leach, Walter, 21, St. Andrew's-place, Bradford

Date of Election.

Dec. 6, 1894	Trans.	Lean, Bevan, D.Sc., B.A., Laurel Bank, Ackworth, near Pontefract
Feb. 2, 1888		Lease, Frank E., Melapi Estate, Sandakan, British North Borneo
Dec. 3, 1891	Trans.	Leather, J. Walter, Ph.D., Dehra Dun, N.W.P., India
Dec. 5, 1889		Ledingham, L. Napier, Longley Farm, Longley, near Sheffield
Feb. 15, 1894		Lee, Clifford W., East Rand Prop. Mines, Boksburg, Transvaal
Dec. 6, 1883		Lee, Herbert C., The New Westminster Brewery Company, Earl-street, Horseferry-road, S.W.
Feb. 1, 1882		Lee, Robert Brewer, B.Sc., B.A., 6, Warwick-street, Kensington, W.
June 18, 1891		Leeds, Frank H., 26, East Bank, Stamford-hill, N.
Feb. 6, 1873		Lees, Charles, Elm Villa, Taunton-road, Bridgwater
Dec. 3, 1891		Leffler, Rudolf, 75, Harcourt-road, Sheffield
May 16, 1889		Legg, John Edmund, M.A., F.I.C., The Grammar School, Wood-bridge, Suffolk
May 7, 1891	Proc.	Leicester, James, 2, Randall-road, Clifton, Bristol
Jan. 17, 1889		Leigh, Cecil, Birmingham Small Arms and Metal Company, Adderley Park Rolling Mills, Birmingham
Dec. 3, 1891		Lennox, Robert N., The Nook, Rose Bank, Crabb Tree, Fulham
June 17, 1886		Leon, John Temple, 38, Portland-place, W.
Feb. 15, 1894		Leonard, Norman, B.Sc., 2A, Lorne-road, Brixton, S.W.
Jan. 19, 1882		Lescher, Frank Harwood, 60, Bartholomew-close, E.C., and 31, Devonshire-place, W.
Feb. 21, 1895	Trans.	Le Sueur, Henry Rondel, B.Sc., St. Thomas's Hospital, S.W.
June 18, 1896		Lethbridge, W. A., Ivy Cottage, St. David's, Exeter
Feb. 6, 1879	Trans.	Letts, Edmund Albert, Ph.D., Queen's College, Belfast
Mar. 15, 1888	Trans.	Lewes, Vivian B., 19, Park-row, Greenwich, S.E.
Mar. 20, 1884		Lewis, A. E., 7, Gilford road, Sandymount, Dublin
Dec. 6, 1894	Trans.	Lewis, W. H., Exeter School, Exeter
Nov. 18, 1869	Trans.	Lewis, W. J., New Museums, Cambridge
Feb. 16, 1888	Trans.	Lewkowitsch, Julius, Ph.D., Lancaster-avenue, Fennel-street, Manchester
Feb. 21, 1878		Lichtenstein, T., Chemical Works, Silvertown, E.
June 18, 1896		Lidgey, C. R., 43, Marmora-road, Honor Oak, S.E.
May 5, 1892		Lindley, Hubert Edward, Rose Villa, Pinner-road, Harrow
April 15, 1886	Trans.	Ling, Arthur R., 45, Lambton-road, Cottenham Park, Wimbledon
Dec. 3, 1896		Littlefield, R. D., 4, Victoria-terrace, Hove, Sussex
Nov. 21, 1853	Trans.	Liveing, G. D., M.A., F.R.S., Cambridge
Nov. 7, 1872	Trans.	Liversidge, Archibald, F.R.S., Prof., University, Sydney, New South Wales
June 21, 1883		Livingston, W. J., London County Council, Spring-gardens, S.W.
Feb. 19, 1880	Trans.	Lloyd, Alfred, The Dome, Bognor, Sussex
Feb. 3, 1876	Trans.	Lloyd, F. J., Agricultural Laboratory, 4, Lombard-court, E.C.

Date of Election.	
May 4, 1893	Lloyd, Herbert, The Electric Storage Battery Co., Drexel Building, Philadelphia, U.S.A.
Dec. 3, 1896	Lloyd, T. H., Penygraig, Pontypridd
Dec. 3, 1896	Lockwood, T. W., Heckmondwike
Feb. 16, 1871	Lockyer, William John, 7, St. Julian's Farm-road, West Norwood, S.E.
Mar. 20, 1884	London, J. Edward, M.D., 62, Main-street, George Town, Demerara
April 18, 1872	Longstaff, George Blundell, M.A., M.B. Oxon., M.R.C.P., Highlands, Putney Heath, S.W.
Feb. 20, 1873	Loram, H. Y., 19, Hillside-road, Stamford Hill, N.
Feb. 7, 1878	Trans. Louis, D. A., 77, Shirland-gardens, Maida Vale W.
May 4, 1882	Love, Edward G., Ph.D., 80, East 55th-street, New York, U.S.A.
June 15, 1882	Lovibond, Thomas Watson, F.I.C., The Tyne Brewery, Newcastle-on-Tyne
Dec. 18, 1884	Low, Charles William, M.B., Stowmarket
Dec. 15, 1856	Lowe, Charles, Summerfield House, Reddish, near Stockport
Feb. 21, 1878	Lowe, Walter Bezant, M.A., Stranraer School, Wickham, near Fareham, Hants
Feb. 3, 1876	Lowe, William Foulkes, A.R.S.M., 9, Hough-green, Chester
Feb. 15, 1894	Lucas, E. W., 44, Kenilworth-road, Kilburn
Dec. 3, 1891	Lndlow, Lionel, Standard Bank of South Africa, Bulawayo, Rhodesia, and Southville, Swansea
Feb. 15, 1877	Trans. Luff, A. P., M.D., B.Sc. (Lond.), 31, Weymouth-street, Cavendish-square, W.
Mar. 6, 1890	Trans. Lumsden, John S., B.Sc., Ph.D. (Mun.), 5, Paradise-road, Dundee
Dec. 5, 1867	Trans. Lunge, Dr. George, Polytechnicum, Zürich, Switzerland
Dec. 4, 1890	Trans. Lunt, Joseph, B.Sc., 46, Arlington-road, Castle Hill, Ealing
Dec. 5, 1872	Trans. Lupton, Sydney, A. Audley Mansions, 44, Mount-street, W.
Feb. 30, 1894	Luty, Arthur, 9, Bryn-y-Mor-crescent, Swansea
Feb. 16, 1893	Trans. Luxmoore, Charles M., D.Sc., University Extension College and Kennet View, Mansfield-road, Reading
May 1, 1873	Lyon, J. B., Brigade Surgeon, Lient.-Col. C.I.E., East India, U.S. Club, 16, St. James's-square, S.W., and 164, Sutherland-avenue W.
Feb. 19, 1874	Lyon, J. G., The Aire Tar Works, Knottingley, Yorks
Nov. 18, 1886	Trans. Lyons, Albert Brown, A.M., M.D.
Eeb. 3, 1859	Lyte, F. Maxwell, M.A., Cantab., F.I.C., A.I.C.E., Hon F.P.P.S., 60, Finborough-road, Kensington, S.W.
June 20, 1878	Macadam, C. T., 61, Brixton-hill, S.W.
May 7, 1896	Macadam, H. E., Odam's Wharf, Victoria Docks, E.

Date of Election.		
Feb. 21, 1853		Macadam, Stevenson, Ph.D., F.R.S.E., Surgeons' Hall, Edinburgh
Feb. 2, 1888		Macadam, Stevenson, J.C.G., jun., Surgeons' Hall, Edinburgh
April 4, 1878		Macadam, W. Ivison, F.R.S.E., Professor New Veterinary College, Surgeons' Hall, Edinburgh
Dec. 2, 1886		Macan, Hugh, M.A., County Hall, Kingston-on-Thames
April 17, 1890		MacArthur, J. Stewart, 12, Knowe-terr., Pollokshields, Glasgow
May 6, 1897		MacCulloch, Charles, 395, Collins-street, Melbourne
Feb. 15, 1894		Macdonald, A. H., 11, Oriel-place, Bath-road, Cheltenham
Dec. 6, 1894	Trans.	MacDonald, G. W., B.Sc., c/o Messrs. Pigou, Wilks, and Lawrence, Dartford, Kent
May 7, 1891		MacDonald, William, Tung Wen Kwan, Imperial Coll., Pekin
Mar. 4, 1886		MacEwan, Peter, 4, Gresley-road, Hornsey-lane, N.
June 18, 1891		Macfie, R. A. Scott, M.A. (Cantab), B.Sc., Rawcliffe R.S.O., Yorks
Feb. 23, 1895		MacFarlane, Alex., 149, Manx-terrace, Blackley, Manchester
Dec. 2, 1880		Macfarlane, James A., Vancouver, B.C.
Mar. 6, 1890		Macintyre, Alfred E., Morrin College, Quebec, P.Q., Canada
Dec. 2, 1887		Mackay, Angus, Technical College, Ultimo, Sydney, N.S.W.
Dec. 4, 1890		Mackean, William, 14, Palmer-street, Westminster, S.W.
Dec. 3, 1874		Mackenzie, D. C., 106, Leadenhall-street, E.C.
Feb. 18, 1892		Mackenzie, Dr. William Cossar, Tewfikieh College of Agriculture, Ghizeh, Cairo
Jan. 15, 1844		MacLagan, Douglas, Sir, M.D., F.R.S.E., University of Edinburgh, and 28, Heriot-row, Edinburgh
Feb. 17, 1881		MacMunn, Charles A., M.A., M.D., F.R.M.S., Oakleigh, Wolverhampton
Feb. 1, 1880		Macnab, William, 14, Great Smith-street, Westminster, S.W.
June 4, 1885	Trans.	Macnair, Duncan Scott, Ph.D., B.Sc., Glenogle, Kilmalcolm, N.B.
April 19, 1888		MacSwiney, E., 13, North Main-street, Cork
April 21, 1864	Trans.	Mactear, James, F.R.S.E., 2, Victoria mansions, Westminster, S.W.
May 1, 1862	Trans.	Madan, H. G., Bearland House, Gloucester
May 5, 1892		Major, George Harry, Devonshire-street, Ardwick, Manchester
Dec. 6, 1894		Makin, C. J. Shaw, 51, Earl's-court-square, S.W.
May 7, 1885		Mallet, F. R., 18, The Common, Ealing, W.
Dec. 17, 1857	Trans.	Mallet, J. W., Ph.D., M.D., F.R.S., University of Virginia, Albemarle Co., Va., U.S.N.A.
May 6, 1897		Mallinson, W. L., Gawthorp-green, Kirkheaton, near Huddersfield
Dec. 3, 1896		Manners, Hugh, M.A., B.Sc., Academy-house, Airdrie, N.B.
Feb. 4, 1858		Manning, F. A., 18, Billiter-street, E.C.
Feb. 7, 1853	Trans.	Marcet, W., M.D., F.R.S., Flowermead, Wimbledon Park, S.W.

Date of Election.

May 16, 1895		Marchant, Robert Charles, M.R.A.S.E., M.R.A.C., 19, Wellington-Park, Clifton, Bristol
Dec. 3, 1896		Marks, E. S., 111, Cromwell-road, S.W.
Feb. 16, 1893	Trans.	Marsden, Fred, M.Sc., Ph.D., Bangor, North Wales
May 16, 1895		Marsden, Prosper, Royal Infirmary, Liverpool
June 16, 1881		Marsh, Charles W., Ph.D.
Feb. 15, 1883	Trans.	Marsh, J. E., M.A., University Museum, Oxford
Feb. 21, 1895		Marshall, Arthur, 65, Fairholme-road, West Kensington
Feb. 6, 1890	Trans.	Marshall, Hugh, D.Sc., F.R.S.E., Chemical Department, University of Edinburgh
June 18, 1896		Marshall, P. S., Bank-top, Lower-houses, Huddersfield
Feb. 19, 1891		Marshall, Reginald Tom, Elmeroft, The Green, Southwick, near Brighton
Nov. 20, 1890	Trans.	Marshall, T. Rhymer, D.Sc., Chemical Laboratory, St. Mungo's College, Glasgow
Dec. 6, 1888	Trans.	Marshall, William, c/o D. G. Rose, Esq., Samarang, Java
June 16, 1887		Marshall, William, F.I.C., 149, Drake-street, Rochdale
June 15, 1893		Martin, Alexander Mitchell, Douglas-villa, Dunbeth-road, Coat-bridge
Mar. 4, 1897		Martin, C. H., 14, Aldred-street-erescent, Salford
Nov. 19, 1885		Martin, Lieut.-Col. Gerald Ward, F.R.G.S., H.M. Mint, Bombay
Dec. 6, 1883		Martin, W. H., 183, King's-road, Chelsea, S.W.
Feb. 16, 1893		Martin, William J., jun., Prof., Ph.D., M.D., Davidson College, Davidson, N.C., U.S.A.
Feb. 19, 1891		Martin, William Morley, 16, Penryn-street, Redruth, Cornwall
April 7, 1870		Martindale, William, 10, New Cavendish-street, W.
June 1, 1871		Martineau, George, 21, Mincing-lane, E.C., and Gomshall Lodge Gomshall, Surrey
Dec. 1 1887		Martineau, Sydney, 4, South-road, Clapham-park, S.W.
June 2, 1851	Trans.	Maskelyne, Nevil Story, F.R.S., Salthrop, Wroughton, Wilts
Feb. 6, 1890		Mason, Francis H.
Mar. 4, 1893		Mason, James, M.D., Otaki, N.Z.
Nov. 4, 1858		Mason, James, Eynsham-hall, near Witney, Oxen
Dec. 5, 1889		Mason, James Braik, 2, Balgay Avenue, Dundee
Dec. 2, 1880		Mason, William Brandwood, 117, Derby-street, Bolton
Jan. 19, 1882	Trans.	Masson, Orme, M.A., D.Sc., Prof. the University of Melbourne, Victoria
Dec. 4, 1873		Masters, William, Sub-Deputy Opium Agent, Gya, Bengal, India, and 82, Oxford-gardens, Notting Hill, W.
Feb. 20, 1896		Mathieson, L. W., County School, Llanrust, North Wales
June 15, 1876	Trans.	Matthews, C. G., St. John's Lodge, Beckenham

Date of Election.		
June 17, 1880	Trans.	Matthews, Francis Edward, Ph.D., Royal Indian Engineering College, Cooper's Hill, Staines, and The Pines, Edglefield Green
Jan. 17, 1884		Matthey, Edward, 78, Hatton-garden, E.C.
May 3, 1870		Matthey, George, F.R.S., 78, Hatton-garden, E.C.
Dec. 7, 1893		Mawer, William Frederick, 332, Kennington-road, S.E.
Dec. 7, 1865		Maxwell, Theodore, B.A., M.D. Camb., B.Sc. Lond., 29, Woolwich-common, S.E.
Dec. 3, 1896		Mayfield, A. S., Avenue-house, Beverley-road, Hull
June 7, 1888		Mayhew, E. W. A.
Dec. 1, 1887		McArthur, John, F.R.S.E., 196, Trinity-road, Wandsworth-common, S.W.
Feb. 2, 1888		McBretney, Edmund G., Pontefract-road, Castleford, York
Feb. 6, 1890	Trans.	McConnell, Arthur H., 35, Bernard-street, Russell-square, W.C.
June 18, 1896		McConnell, William, jun., 25, Percy-gardens, Tynemouth
Feb. 4, 1875		McCowan, William, F.I.C., 45, Mott-street, Birmingham
May 7, 1896		McCrae, John, jun., Ph.D., 9, Kirklee-gardens, Kelvininside, Glasgow
Dec. 5, 1895		McCreath, James, Auchenwinn, Maybole, Ayr, N.B.
Nov. 20, 1890		McCubbin, William A., 8, Cook-street, Liverpool
Dec. 6, 1894		McCutcheon, Jas., Marchmont, Lanark
Dec. 17, 1857		McDougall, Alexr., 61, Liverpool-road, Birkdale, Southport
Dec. 17, 1874		McDougall, John, Clifton House, Greenwich-park, S.E.
June 15, 1893		McElroy, K. P., 1412, 16th-street, Washington, D.C., U.S.A.
Feb. 18, 1892		McFall, J. E. Whitley, Bankfield-road, West Derby, Liverpool
May 16, 1895		McGlasban, T., Sugar Works, Cawnpore
Mar. 3, 1887	Trans.	McGowan, George, Ph.D., 1, Mount-avenue, Ealing
May 4, 1893		McGregory, Joseph Frank, Prof., Hamilton, New York, U.S.A.
June 15, 1893		McKerrow, Charles Alexander, 18, Exchange-street, Manchester
May 5, 1892		McKerrow, William James, D.Sc., Messrs. Field and Co., Upper Marsh, Lambeth, S.W.
Feb. 6, 1868	Trans.	McLeod, Herbert, F.R.S., Indian Civil Engineering College, Cooper's Hill, Staines
June 7, 1894		McLeod, Jas., 5, Gladstone-terrace, Paisley
Feb. 17, 1881		McMillan, Walter George, Metallurgical Laboratory, Mason College, Birmingham
April 4, 1889	Trans.	McMurtry, George Cannon, Wallaroo Smelting Works, Wallaroo, S. Australia
Feb. 21, 1895		McVey, W. B., 301, Saratoga-street, Boston, U.S.A.
Feb. 18, 1892		Meacham, Chas. Stephen, Pettridge, Maidstone
June 18, 1896		Meggitt, Loxley, The Laboratory, Sutton-in-Ashfield, Notts.
Feb. 16, 1871	Trans.	Meldola, Raphael, F.R.S., 6, Brunswick-square, W.C.
Feb. 21, 1895		Meldrum, Robt., Cockranfield, Millikan Park, Renfrewshire
Feb. 15, 1894		Melland, Godfrey, B.Sc., Univ. College, Nottingham
May 20, 1875		Melmore, Pattinson B., Chemical Laboratory, Maryport

Date of Election.

Dec. 18, 1884		Mercer, Francis M., 89, Bishopsgate-street-within, E.C.
Dec. 5, 1889		Mercer, Thomas, Great Hey, Edenfield, near Bury, Lancashire, and Ring Bank Brewery, Edenfield, near Bury
May 7, 1896		Merrett, W. H., Lambeth Brass and Iron Works, Short street Lambeth
May 7, 1891		Merrils, Frederick Johnson, 371, Glossop-road, Sheffield
May 6, 1897		Merson, G. F., 55, Northumberland-street, Newcastle-on-Tyne
April 20, 1876	Trans.	Messel, Rudolph, Ph.D., 30, Ebury-street, S.W.
June 21, 1888	Trans.	Miers, Henry A., M.A., F.G.S., Magdalen College, Oxford
Feb. 18, 1892	Trans.	Millar, James Hill, c/o Mr. Horace Brown, 72, Chancery-lane, W.C.
Dec. 18, 1843		Millar, James,
Feb. 19, 1891		Millard, Edgar J., F.R.M.S., 40-42, Charlotte-street, Great Eastern-street, E.C.
Feb. 19, 1880	Trans.	Miller, A. K., Ph.D., Kilvert's-buildings, Withy-grove, Manchester
Feb. 21, 1889		Miller, Harry East, Ph.D., 1264, Fourteenth-street, Oakland, California
April 4, 1889	Trans.	Miller, James Bruce, A.I.C., Rubislaw Den, North Aberdeen
Dec. 1, 1887		Miller, John A., Niagara University, Buffalo, New York
May 7, 1885	Trans.	Miller, N. H. J., Ph.D., Harpenden, Hertfordshire
Dec. 3, 1896		Miller, W. M., Prye Estate, Wellesley Province, Penang, S.S.
June 15, 1893	Trans.	Mills, Charles, 21, St. Mary Abbotts-terrace, W.
Dec. 18, 1862	Trans.	Mills, E. J., D.Sc., F.R.S., Young Professor of Technical Chemistry in the Glasgow and West of Scotland Technical College, 60, John-street, Glasgow
May 7, 1885		Milne, Alexander, M.A., M.B.
June 21, 1877		Milne, G. A., Chemical Laboratory, 18, John Brown-street, Bolton
May 5, 1892		Milnes, Ernest E., 16, Ashfield, Bradford
Dec. 1, 1887		Mingaye, John C. H., Department of Mines, Assay Branch, Sydney
May 7, 1891	Proc.	Mitchell, Charles Ainsworth, B.A. Oxon., 32, Oakley-crescent, Chelsea, S.W.
June 18, 1891		Mitchell, Thomas, c/o E. Mitchell, Esq., Crossmount, Bridgend, Perth, N.B.
June 18, 1896		Mitra, Asutosh, Rai Buhadur, Chief Medical Officer, Kashmir
Feb. 16, 1893		Mole, H. Bloome, Hill Side, Shepton Mallet
Feb. 15, 1872	Trans.	Mond, Ludwig, Ph.D., F.R.S., 20, Avenue-road, St. John's-wood, N.W.
Feb. 18, 1892		Mond, Robert Ludwig, M.A., F.R.S.E., The Poplars, 20, Avenue-road, Regent's Park, N.W.
Dec. 18, 1879		Mondy, Edmund F., Dacca College, Dacca, Bengal
Mar. 3, 1887	Trans.	Moody, G. Tattersall, D.Sc., Lorne House, North Dulwich, S.E.,
May 5, 1892		Moor, Cresacre George, B.A., State Med. Lab., King's College, Strand, W.C.

Date of Election.		
Feb 19, 1891		Moore, Frederick Herbert, Strada degli Argentieri, 19, Messina, Sicily
Mar. 6, 1896		Moore, Ira, Ph.D., 64, Mottram-road, Hyde, near Manchester
Dec. 5, 1895		Morgan, D. J., 10, Northampton-place, Swansea
Jan. 7, 1888		Morgan, John James, Riverdale, Abergavenny, Mon.
Dec. 7, 1893		Morgan, J. R., 57, Coldstream-street, Llanelly
June 20, 1895		Morison, J., Colonial Sugar Refining Company, 5, O'Connell-street, Sydney
June 17, 1880	Trans.	Moritz, Edward R., Ph.D., 72, Chancery-lane, W.C.
Dec. 18, 1879	Trans.	Morley, H. Forster, M.A., 47, Broadhurst-gardens, South Hampstead, N.W.
May 16, 1895	Trans.	Morrell, R. S., M.A., Ph.D., Gonville and Caius College, Cambridge
May 5, 1892		Morris, Albert, B.Sc., Fern Bank, Dunkinfield
Feb. 19, 1880	Trans.	Morris, G. Harris, Ph.D., 72, Chancery-lane, W.C., and 18, Gwendwr-road, West Kensington, W.
Dec. 3, 1891		Morris, Joseph, Ph.D., 87, Old Trafford-road, Eccles, Manchester
May 7, 1891		Morrison, George R., Richmond House, Plaistow, Essex
Dec. 15, 1851		Morson, Thomas, 124, Southampton-row, Russell-square, W.C., and 42, Gordon-square, W.C.
Feb. 16, 1872		Morton, Edward Handfield, Campayne-mansions, Campayne-gardeas, South Hampstead
Dec. 7, 1893		Morton, Frederick, 101, Quarmby-road, Huddersfield
April 17, 1890	Trans.	Mosenthal, Henry de, 220, Winchester House, Old Broad-street, E.C.
Dec. 3, 1896		Moss, Frank A., Menzies, W. Australia
Jan. 19, 1871		Moss, John, 33, Tressillian-road, St. John's, S.E.
Jan. 19, 1871		Moss, Richard J., F.I.C., St. Aubyn, Ballybrack, Co. Dublin
Dec. 3, 1896		Mothe, J. T. de la, Grand Bacolet Estate, St. Andrew's Parish, Grenada, W.I.
April 15, 1886		Moul, Frank, Aldersgate Chemical Works, Southall
Feb. 16, 1884		Moyle, R. E., M.A., Heightley, Chudleigh, Devon
Jan. 17, 1889		Muir, James, The Yorkshire College, Leeds
June 18, 1896		Muir, J. Stanley, B.Sc., The Gold and Silver Extraction Co., Limited, 208-210, McPhee-buildings, Denver, Colorado, U.S.A.
Feb. 16, 1871	Trans.	Muir, M. M. Pattison, M.A., Fellow and Prælector in Chemistry, Gonville and Caius College, Cambridge
Mar. 30, 1870		Muirhead, Alexander, D.Sc., The Lodge, Shortlands, Kent
Feb. 3, 1859	Trans.	Müller, Hugo, Ph.D., F.R.S., 110, Bunhill-row, E.C.; and 13, Park-square East, Regent's Park, N.W.
May 4, 1893	Proc.	Munby, Alan E., Felstead School, Essex
Mar. 15, 1838		Munroe, Charles E., Prof. Columbia University, Washington, D.C., U.S.A.

Date of Election.

Dec. 7, 1871		Munro, Donald, M.D., C.M., D.P.H., Medico-Legal Department, University of Glasgow
Feb. 17, 1876	Trans.	Munro, J. M. H., D.Sc., Churchfields, Salisbury
May 4, 1893		Murray, J. Alan, 5, Caergog-terrace, and University College of Wales, Aberystwyth
Feb. 15, 1894		Murray, John Moore, Esq., Municipal Technical School, Arundel-street, Portsmouth
Dec. 4, 1890	Trans.	Murray, Thomas Smith, D.Sc., Chemical Department, The University, Aberdeen
Jan. 21, 1869		Muspratt, E. K., Seaforth-hall, near Liverpool
Dec. 3, 1873		Muspratt, Sidney Knowles, 24, Grove-park, Liverpool
Dec. 3, 1896		Muter, A. H. M., A. I. C. Laboratory, 325, Kennington-road, S.E., and The Châtelet, Horley, Surrey
Nov. 3, 1870	Trans.	Muter, John, Ph.D., F.R.S.E., F.I.C., Laboratory, 325, Kennington-road, London, S.E., and The Châtelet, Horley, Surrey
Dec. 4, 1890	Trans.	Myers, Harry C., Ph.D., University of Washington, Seattle, Wash., U.S.A.
Feb. 18, 1892	Trans.	Myers, William Shields, M.Sc., 98, Easton-avenue, New Brunswick, U.S.A.
Mar. 6, 1890		Myles, John, M.A., B.Sc., Principal, Reinet College, Cape Colony
Feb. 3, 1887		Nagel, David Henry, M.A., Trinity College, Oxford
Mar. 5 1874		Napier, Arthur S., c/o Herren Mayer & Müller, 51, Markgrafen-strasse, Berlin, W., Germany
June 21, 1877		Napier James, 89, London-road, Ipswich
June 15, 1893		Napier, John Watson, Gas Works, Auchterarder, N.B.
Dec. 5, 1878		Napper, Edward W., Denbigh-road, St. Asaph
Dec. 3, 1891		Naylor, William, 16, Walton's-parade, Preston
April 4, 1878		Naylor, W. A. H., 38, Southwark-street, S.E.
Dec. 3, 1891		Neilson, Thos.
April 4, 1878	Trans.	Nevile, R. H. C., Crown Lea, Malvern
June 1, 1871	Trans.	Nevill, Edmund Neville, Gov. Lab., Durban, Natal
April 17, 1890	Trans.	Neville, Francis Henry, F.R.S., Sidney College, Cambridge
June 16, 1892		Newall, John Fenton, 8, Market-place, Manchester
June 4, 1885		Newbolt, Francis George, 1, Mitre-court-buildings, E.C.
April 19, 1860	Trans.	Newlands, John A. R., Laboratory, 2, St. Dunstan's-hill, E.C.
Feb. 18, 1864		Newlands, B. E. R., 2, St. Dunstan's-hill, E.C.
Dec. 3, 1891		Newlands, William, P. R., 1, Mildenhall-road, Lower Clapton, N.E.
April 4, 1889		Newsholme, G. T. Wilkinson, 27, High-street, Sheffield
June 7, 1894	Trans.	Newth, G. S., Royal College of Science, South Kensington
May 16, 1895		Newton, C. B., Gas Works, Carlisle
Dec. 18, 1879		Newton, Howard, Water Engineer, the Municipality, Bombay
Mar. 4, 1886		Newton, Walter, Beech Villa, Park-lane, Macclesfield

Date of Election.		
Mar. 1, 1883		Newton, William, Ph.D., F.I.C., 39, Mincing-lane, London, E.C.
Dec. 15, 1892		Nickolls, J. Bate, The Laboratory, Guernsey
Feb. 16, 1870	Trans.	Nicholson, Edward, Brigade Surgeon, Lient.-Col., 10, Alexander-road, Waterloo, Liverpool
June 4, 1885	Trans.	Nicholson, T. Goddard, M.B. Lond., B.Sc., M.R.C.S., L.R.C.P.
Dec. 5, 1839		Nickels, Wallace Christopher, 54, Dyne-road, Brondesbury, N.W.
Feb. 1, 1883	Trans.	Nicol, W. W. J., 15, Blacket-place, Edinburgh
June 7, 1894		Nixon, Alf., Central School, Deansgate, Manchester
May 6, 1869		Noble, Captain Sir A., Engineer, Elswick Ordnance Works, Newcastle
Dec. 5, 1889		Norman, John T., Avalon, Putney Common, S.W.
April 4, 1861		Norrington, Frederick, 5, Downfield-road, Clifton, Bristol
June 16, 1892		Norris, Charles James, 24, Ravenscourt-gardens, Hammersmith
Mar. 4, 1897	Trans.	North, Barker, 3, Manor-terrace, Felixstowe
May 5, 1892		Northing, John, The Murrough, Wicklow
Dec. 18, 1854		Norton, Fletcher, Longtown, Abergavenny
April 4, 1878		Norton, Prof. T. H., Ph.D., University of Cincinnati, Ohio, U.S.A.
June 18, 1891		Notter, J. Lane, M.A., M.D., West Cliff, Woolstone, Southampton
May 4, 1893	Proc.	Oates, William Henry, Broomhall Park, Sheffield
Mar. 4, 1886		Obach, Eugene, Ph.D., F.I.C., 2, Victoria-road, Old Charlton, Kent
May 15, 1890		Oddy, Robert Walter, Waterhouse, Toad-lane, Rochdale
Jan. 19, 1873		Odling, Walter, 132, High-street, and at Messrs. Bass & Co., Burton-on-Trent
Jan. 17, 1848	Trans.	Odling, William, M.B., F.R.S., 15, Norham Gardens, Oxford
May 4, 1871		Ogston, G. H., Analytical Laboratory, 39, Lime-street, E.C.
June 20, 1889		O'Mahony, D. J., Municipal-buildings, Cork
Dec. 4, 1890	Trans.	Ormandy, Wm. Reginald, 250, Denton's Green Lane, St. Helens, Lancs.
Nov. 4, 1869		Orme, Temple A., University College, W.C., and 213, Uxbridge-road, W.
May 16, 1872		Ormerod, Joseph Arderne, M.B., M.R.C.P., The Library, St. Bartholomew's Hospital, E.C.
Dec. 6, 1894		Ormerod, T., 362, Padiham-road, Burnley, Lancs.
Dec. 1, 1887		Ormiston, Archibald R., Heathland, Uddingston; and 203, St. Vincent-street, Glasgow
June 15, 1893		Orr, Alexander, 109, Pitt-street, Sydney, Australia
Feb. 21, 1884	Proc.	Orsman, W. J., jun., The Roburite Explosives Co., Gathurst, near Wigan

Date of Election.		
May 6, 1897		Orton, K. J. P., B.A., Ph.D., 20, Loughborough-road, Brixton, S.W.
Mar. 17, 1881	Trans.	O'Shea, L. Trant, Firth College, Sheffield
Dec. 1, 1887		Ostersetzer, Julius, Messrs. W. and H. M. Goulding, Manure Manufacturers, North Wall, Dublin
April 20, 1876	Trans.	+O'Sullivan, C., F.R.S., 140, High-street, Burton-on-Trent
Mar. 1, 1883	Trans.	O'Sullivan, James, High Bank, Burton-on-Trent
Mar. 17, 1887		O'Sullivan, Patrick T., M.B., B.C.L., 34, South Mall, Cork
May 7, 1891		Ough, Lewis, Curzon-terrace, Sparkenhoe-street, Leicester
Feb. 16, 1888		Overbeck, Otto C. J. G. L., Chantry House, Great Grimsby
June 16, 1887		Overend, Fred. Lawrence, B.A. (Oxon), Royal Grammar School, Sheffield
June 18, 1896		Overton, J. H., Technical School, Marlborough-road, Banbury
Feb. 16, 1893		Owen, Robert Henry, Bush Hotel, Dowlais
Dec. 15, 1851		Oxland, Robert, Dr., 32, Portland-square, near Plymouth
Dec. 21, 1871	Trans.	Page, Frederick James Montague, B.Sc., 54, Sutherland-street, Pimlico, S.W.
June 18, 1896		Page, H. M., Headmaster, Govt. College of Science, Poona, Bombay Presidency
Jan. 17, 1884		Pallister, J. W., B.Sc., 22, Grimthorpe-terrace, Headingley, Leeds
May 4, 1882		Palmer, Alfred Neobard, Inglenook, Bersham-road, Wrexham
April 19, 1888		Palmer, Henry John, Victoria Lodge, Yelverton, R.S.O., Devon
April 17, 1879		Palmer, Walter, Univ. Extension College, Reading
Mar. 4, 1897		Parker, C. H., Manor House, Tettenhall, Wolverhampton
Jan. 19, 1882		Parker, Joseph R., Avondale, Beaver-road, Ashford
May 3, 1894	Proc.	Parker, Matt. A., B.Sc., 13, Hamilton-crescent, Partick, Glasgow
Dec. 7, 1882		Parker, R. H., 35, Clifton-road, Maida Vale, W.
Nov. 20, 1890		Parkes, Thomas, M.A., 30, Hopwood-street, Barnsley
Nov. 2, 1865	Trans.	Parkinson, James, F.G.S., Queen's-chambers, Pirie-street, Adelaide, South Australia
May 4, 1893		Parrish, S., 1, Highfield-terrace, Kingston-road, Leeds
Feb. 18, 1892		Parry, Ernest John, B.Sc., Fairview, High-street, Hampton Hill, Middlesex
May 17, 1888		Parsons, William, Dispensary, St. Bartholomew's Hospital, E.C.
April 21, 1870		Patchett, Isaac, F.I.C., 1, Leopold-square, Leeds
Feb. 15, 1894		Paterson, David, Lea Bank, Roslin, N.B.
Mar. 5, 1885	Trans.	Patterson, George, The Manbré Saccharine Co., Hammersmith, W.
May 7, 1896		Patterson, J. W., 14, Mitchell-street, W. Hartlepool, Durham
May 16, 1895		Patterson, L. G., Washington Carbon Company, Washington, Pa.
Mar. 17, 1870	Trans.	Patterson, T. L., Maybank, Finnart-street, Greenock

† Longstaff Medallist, 1884.

Date of Election.		
Dec. 3, 1863	Trans.	Pattinson, John, 75, The Side, Newcastle-upon-Tyne
Mar. 5, 1868	Trans.	Paul, Dr. B. H., Analytical Laboratory, 20, Victoria-street, Westminster, S.W., and Parkside, Kingston Vale, Putney, S.W.
Dec. 3, 1885	Trans.	Paul, Lewis Gordon, Ph.D., Messrs. Read, Holliday and Sons, Huddersfield
Feb. 15, 1894		Paulusz, Richd., Maradana, Colombo, Ceylon
June 18, 1896		Payne, Arthur, c/o Messrs. Mawson and Swan, Mossley-street, Newcastle-on-Tyne
Dec. 7, 1893		Payne, George F., M.D., Atlanta, Georgia, U.S.A.
Feb. 15, 1894		Pearson, William Henry, 6, Fenchurch-buildings, E.C.
Jan. 16, 1874	Trans.	Pearce, William, Chemical Works, Bow Common, E.
May 7, 1896		Pechmann, H. von, Prof., Tübingen, Germany
Feb. 15, 1894		Peden, John, jun., Chemical Laboratory, 11, Duff-street, Greenock
Feb. 4, 1870	Trans.	Pedler, Alexander, Prof., F.R.S. Presidency College, Calcutta
May 20, 1886	Proc.	Pendlebury, William Henry, M.A., 6, Gladstone-terrace, Dover
Mar. 7, 1870		Penney, M. D., 11, High-street, Hull
Dec. 5, 1895		Pennington, W. H., Field House, Rochdale
Dec. 16, 1886		Pentecost, Stephen James, Nottingham-road, New Basford, Nottingham
Jan. 17, 1889	Trans.	Percival, John, M.A., S.E. Agric. Coll., Wye, near Ashford
April 17, 1884	Trans.	Perkin, A. G., 8, Montpelier-terrace, Hyde Park, Leeds
June 18, 1891	Trans.	Perkin, Frederick M., The Chestnuts, Sudbury, Harrow
Dec. 15, 1856	Trans.	† Perkin, W. H., LL.D., Ph.D., F.R.S., The Chestnuts, Sudbury, Harrow
April 17, 1884	Trans.	Perkin, W. H., jun., F.R.S., Fairview, Wilbraham-road, Fallowfield, Manchester
Feb. 6, 1890	Trans.	Perman, Edgar Philip, D.Sc., University College, Cardiff
Dec. 6, 1888		Perry, George Edward, 6, Norwood-villas, Edgbaston, Birmingham
June 16, 1881		Phillip, Arnold, A.R.S.M., B.Sc. Lond., F.I.C., The Merchant Venturers' Technical School, Bristol
Feb. 1, 1887		Phillips, A. G., 18, Fopstone-road, Kensington, S.W.
June 20, 1889		Phillips, Benjamin, Victoria House, Byculla, Bombay
May 6, 1897		Phillips, H. E. W., B.A., 47, Chalfont-road, Oxford
Feb. 16, 1882		Phillips, Henry Harcourt, 183, Moss-lane East, Manchester
Feb. 21, 1889		Phillips, Henry Joshua, Palace-chambers, Westminster, S.W.
May 6, 1897	Trans.	Pickard, R. H., B.Sc., Southfields, Priory-road, Edgbaston, Birmingham
Feb. 19, 1891		Pickering, M. Samuel, B.Sc., Lond., 38, Price-street, Burslem
Feb. 7, 1878	Trans.	Pickering, Spencer Percival Umfreville, M.A., F.R.S., 48, Bryanston-square, W., and Harpenden, Herts
April 17, 1890	Trans.	Picton, Harold, B.Sc., Parmiters School, Approach road, Victoria-park, N.E.

† Longstaff Medallist, 1889.

Date of Election.

June 7, 1894		Pike, E. Brookes, 515, Romford-road, Forest-gate, E.
Jan. 15, 1874	Trans.	Pike, William Herbert, Ph.D., University, Toronto, Canada
Dec. 20, 1883		Pilley, John J., Ph.D., 167, Camberwell Grove, S.E.
May 7, 1896		Pilley, T. W., 33, Grove-hill-road, Denmark-hill, S.E.
Dec. 5, 1889		Ping, William, 2, Sandbourne-road, Brockley, S.E.
Feb. 21, 1889		Pingstone, C. Arthur, The Goldfields of Matabele Land, Limited, Bulawayo, Rhodesia, S.A.
Mar. 17, 1881		Pisani, O. V., Effingham-house, Arundel-street, Strand, W.C.
Feb. 16, 1882		Pitt, Theophilus, 16, Coleman-street, E.C.
Feb. 16, 1893		Platt, Charles, Ph.D., Hahnemann Med. Coll., Philadelphia, U.S.A.
April 4, 1889		Platts, John Charles, 54, Marlborough-road, Moor Oaks, Sheffield
Nov. 15, 1860		Player, J. H., 16, Prince Arthur-road, Hampstead, N.W.
Feb. 23, 1841	Trans.	* Playfair, Right Hon. Lord, K.C.B., F.R.S., 68, Onslow-gardens, South Kensington
Dec. 2, 1880	Trans.	Plimpton, R. T., Ph.D., 23, Lansdowne-road, Clapham-road, S.W.
June 7, 1888		Pollard, F. Ernest, Old Cross, Hertford
May 7, 1896		Pollitt, R. B., 2, Woodleigh-villas, Stowmarket
May 4, 1897		Pollitt, Samuel, B.Sc., 56, Wandsworth-bridge-road, Fulham, S.W.
Feb. 15, 1894		Pollok, J. Holms, Royal College of Science, Dublin
Dec. 4, 1890		Pond, James Alexander, Auckland, New Zealand
Dec. 4, 1848		Pontifex, Edmund A., M.I.C.E., 72, Cornwall Gardens, S.W.
Mar. 6, 1862		Pooley, Thomas A., B.Sc., F.I.C., 121, The Grove, Denmark Hill, S.E.
Feb. 19, 1891	Trans.	Pope, Wm. Jackson, Central Technical College, Exhibition-road, S.W., and 16, Barclay-road, Walham Green, S.W.
Dec. 18, 1884		Porter, T. Cunningham, Rev., Eton College, Windsor
June 20, 1895		Potter A. E., M.A., B.Sc., Inspector of Schools, Rangoon, Burmah
Dec. 6, 1883		Potter, Charles E., c/o Messrs. Tate & Sons, Love-lane Sugar Refinery, Liverpool
Dec. 3, 1896		Potts, H. W., Euroa, Victoria, Australia
Feb. 21, 1895		Powell, H. James, 530, Lordship-lane, S.E.
Dec. 3, 1896		Power, F. B., Ph.D., 21, Queen's-square, W.C.
Feb. 21, 1884		Power, Francis R., The Royal Mint, Melbourne
May 19, 1864		Prentice, Manning, Woodfield, Stowmarket
Mar. 2, 1876	Trans.	Prescott, Albert B., M.D., University, Ann Arbor, Michigan, U.S.A.
Dec. 5, 1872	Trans.	Prevost, E. W., Ph.D., Elton, Newnham, Gloucester
May 4, 1882		Price, Arthur F., 524, Sacramento-street, San Francisco
Dec. 5, 1895	Trans.	Priest, Martin, Apothecaries Hall, Blackfriars, E.C.
Jan. 17, 1889		Priestley, Charles W., B.Sc., Vivian Institute, Torquay
Feb. 17, 1870		Pritchard, Prof. William, President Royal Veterinary College, N.W.; and 5, Regent's Park-road, Gloucester-gate, N.W.

Date of Election.

June 15, 1871	Trans.	Procter, Henry R., F.I.C.. The Yorkshire College, Leeds, and Thornleigh, Ilkley, Yorkshire
April 4, 1889		Proctor, Charles, Upland House, 359, Upland-road, Dulwich, S.E.
May 7, 1896		Proude, James, 13, Oak-terrace, Halifax
Jan. 17, 1889		Provis, John, Zeehan, Tasmania
Mar. 4, 1897		Pullar, H. S., Rosebank, Perth, N.B.
June 15, 1882		Pullar, Rufus D. Ochil, Kinnoul, Perth
Feb. 18, 1892	Trans.	Pullinger, William, B.A., Ash Lea, Romiley, Stockport
June 21, 1883		Purcell, M. F., 41, Lower Bagot-street, Dublin
June 3, 1875	Trans.	Purdie, Thomas, F.R.S., Ph.D., B.Sc., Assoc. R.S.M. University, St. Andrews, N.B.
Dec. 2, 1886		Pyke, L. S. M., A.M.I.C.E., M.I.C.E., F.R.I., 44, Kensington, Park-gardens, W.
Mar. 4, 1868		Quibell, Oliver, Magnus Lodge, Newark-on-Trent
Dec. 5, 1889	Trans.	Quinke, Frederick, Ph.D., Lindenstrasse, 29, Glauchau, Germany
Dec. 6, 1894		Quinn, Gerald G., 16, Albert-street, Newcastle-under-Lyme, Staffs.
Feb. 15, 1894		Quinn, J. Cardwell, Manor Rubber Mills, Aston Cross, Birmingham
Mar. 4, 1897		Ralston, William. B.Sc., 337, Cathcart-road, Glasgow
Dec. 15, 1892	Trans.	Ramage, Hugh, Royal College of Science, Dublin
Nov. 15, 1888		Ramsay, A. Alexander, Anan Villa, Rose-road, Auckland
Mar. 20, 1873	Trans. +	Ramsay, W., Ph.D., F.R.S., University College, W.C., and 12, Arundel-gardens, Notting-hill, W.
May 7, 1891		Randall, Percy Morrice, 3, Belsize Park-gardens, N.W.
April 18, 1843		Randall, William B., 52, Archers-road, Southampton
Dec. 3, 1885		Ranken, Charles, Stockton-road, Sunderland
May 16, 1889		Ransom, Francis, 12, Baneroft, Hitchin
June 17, 1880		Rawson, Christopher, 2, Melbourne-place, Bradford
Jan. 17, 1884	Trans.	Rawson, Sidney George, D.Sc., Technical Schools, Huddersfield
May 7, 1896		Raymond, R. St. G., 30, Britannia-square, Worcester
April 4, 1889	Trans.	Read, Arthur A., 3, Fitzalan-place, Cardiff
June 20, 1895		Read, E. J., B.A., 90, Storks-road, Bermondsey, S.W.
Nov. 20, 1890		Redding, Richard James, 17, Leghorn-road, Plumstead, S.E.
Jan. 15, 1874	Trans.	Reddrop, Joseph, Laboratory, L. and N.W. Ry., Crewe
July 16, 1892		Redman, Henry Ramsden, 150, Canterbury-road, New Brompton
Jan. 13, 1866		Redwood, Boverton, F.R.S.E., 4, Bishopsgate-street-within, E.C.
June 20, 1889		Redwood, Robert, 4, Bishopsgate-street-within, E.C.
Mar. 17, 1887		Redwood, T. Horne, 15, Red Lion-square, W.C.
Nov. 18, 1886	Trans.	Rée, Alfred, Ph.D., Guildhall Chambers, Lloyd-street, Manchester
Dec. 7, 1893		Rees, George Percival

† Longstaff Medallist, 1897.

Date of Election.		
Nov. 16, 1882	Proc.	Reed, Lester, F.I.C., Hyrst-hof, 8, South Park-hill-road, Croydon, S.E.
April 15, 1880		Regester, William, Lawn-lodge, Isleworth, Middlesex
Dec. 7, 1893		Reid, Thomas Anderson, Wincham-house, Lostock, Gralam, Northwich
Dec. 15, 1881		Reid, Walter Francis, Fieldside, Addlestone, Surrey
May 7, 1896		Reissman, C. H., B.A., B.Sc., Saxony-villa, Oppidans-road, Primrose-hill, N.W.
June 17, 1886		Remington, J. Price, Prof., 1832, Pine-street, Philadelphia, Pa., U.S.A.
Mar. 4, 1897		Remington, J. S., Dromore, Milverton, Leamington.
Feb. 6, 1879	Trans.	Rennie, Edward H., Ph.D., University of Adelaide, S. Australia
May 17, 1888	Trans.	Reynolds, Colonel Henry Charles, Thorncliff, Landown-road, Cheltenham
June 19, 1873	Trans.	Reynolds, James Emerson, Prof., D.Sc., M.D., F.R.S., Trinity College, Dublin
Nov. 19, 1857		Reynolds, Richard, 13, Briggate, Leeds
June 18, 1891		Rhodes, Edward, Highfields, Frodsham, Cheshire
May 18, 1876		Richards, D. H., Bryntirion, Oswestry
April 4, 1889		Richards, Duncan T., 3, Madeira-terrace, Westoc-lane, South Shields
Jan. 17, 1889		Richards, Edgar, 341, West 88th Street, New York, U.S.A.
Jan. 17, 1889		Richards, Percy A. E., F.I.C., 12, Wolverton-gardens, West Kensington, W.
June 17, 1886		Richards, William, B.Sc., The Clock House, Tooting, S.W.
May 5, 1892		Richardson, Rev. Albert Ernest, 8, Great Coleman-street, Ipswich
June 18, 1885	Trans.	Richardson, Arthur, 37, Hornby-road, Bombay
Feb. 16, 1888	Trans.	Richardson, Clifford, Laboratory, Barber Asphalt Co., Long Island City, New York, U.S.A.
Feb. 1, 1883		Richardson, F. W., 2, Farcliffe-place, Bradford
Mar. 6, 1873		Richardson, Henry, Lyndene, Hale-road, Bowdon, Cheshire
Dec. 6, 1888		Richardson, Hubert N. B., The Hawthorns, Knighton Park-road, Leicester
April 19, 1866		Richardson, Joseph, jun., 40, Warwick-road, Chorlton-cum-Hardy, Manchester
Dec. 1, 1864		Richardson, J. G. F., Ph.D., Elmfield, Knighton, Leicester
May 5, 1892		Richardson, Reginald E. S., Elmfield, Knighton, Leicester
Nov. 17, 1887		Richardson, W. H., Dudley
Mar. 3, 1887	Trans.	Richmond, H. Droop, Rodbourne, Claremont-road, Twickenham
Feb. 3, 1845		Rickard, W. T., 136, Maygrove-road, West Hampstead, N.W.
Dec. 6, 1894		Riddick, D. G., Stores Department, G.E.R., Stratford, E.
Dec. 7, 1882	Trans.	Rideal, Samuel, D.Sc., F.I.C., 28, Victoria-street, Westminster, S.W.
April 3, 1873		Rider, Alonzo John, 4, Haddington-road, Stoke, Devonport

Date of Election.		
Dec. 5, 1895		Ridge, W. T. B., 2, Ashwood-terrace, Longton, Staffs.
Feb. 16, 1882	Trans.	Ridsdale, C. H., Hutton-grange, Guisbrough, Yorks
Dec. 6, 1888		Rigby, John S., 26, Bagot-street, Wavertree, Liverpool, and Ditton, Lancashire
Dec. 15, 1851	Trans.	Riley, Edward, 14A, Finsbury-square, E.C.
May 4, 1893		Rintoul, William, Royal Gunpowder Factory, Waltham Abbey
June 15, 1893		Ritchie, George, "Hailey," Mount Vernon, N.B.
May 4, 1893		Robbins, James H., 4, Selborne-road, Ilford
April 13, 1872		Robbins, John, 57, Warrington-crescent, Maida-vale, W.
June 21, 1883		Roberts, Frederick G. Adair, Warton-road, Stratford, E.
Jan. 20, 1876		Roberts, Martin Fenn, Postal Telegraph Factory, Mount Pleasant, Clerkenwell, E.C.
April 4, 1889		Roberts, R. Wightwick, c/o A. W. Rowe, Esq., Dashwood House, 9, New Broad-street, E.C.
May 3, 1894		Roberts, Thos. John, 31, North-road, St. Helens, Lancs.
Feb. 19, 1880		Roberts, W. Brittain, Wilderspool House, Warrington, Lanca- shire
Nov. 7, 1866	Trans.	Roberts-Austen, William Chandler, C.B., F.R.S., Royal Mint, E.
Feb. 15, 1894		Robertson, A. B., Struan, Lugar-street, Coatbridge, N.B.
Mar. 17, 1887		Robertson, George, London Hospital, E., and Madeira-villa, Woodford Green, Essex
Dec. 4, 1890	Proc.	Robertson, George Henry
Feb. 21, 1889		Robins, Harry H., Messrs. Southwell and Co., Dockhead, S.E.
May 5, 1881		Robinson, G. Carr, Royal Institution, Hull
Nov. 16, 1882	Trans.	Robinson, Henry H., M.A., Wuchang, Hankow, China
May 7, 1896		Robinson, H. F., B.Sc., Sparthfield, Droylsden-road, Newton- heath, Manchester
Feb. 21, 1895		Robinson, H. Lewin, Chemical Laboratory, Maxim Nordenfelt Co., Erith, Kent
May 3, 1866		Robinson, John, 2, Ornan-mansions, Hampstead, N.W.
Dec. 15, 1892	Trans.	Robson, James, Andersonian-buildings, 204, George-st., Glasgow
Dec. 20, 1883		Rogers, Arthur W., Tadcaster Tower Brewery Co., Tadcaster
Jan. 17, 1884		Rogers, Francis M., 21, Burma-road, Stoke Newington, N.
June 7, 1894		Rolfe, John F., 18, Victoria-street, Clayton-le-Moors, Lancashire
April 15, 1886		Roose, Robson, M.D., 45, Hill-street, Berkeley-square, W.
Dec. 17, 1855	Trans.	Roscoe, Sir H. E., LL.D., D.C.L., Ph.D., F.R.S., 10, Bramham- gardens, South Kensington, S.W.
Feb. 19, 1891	Trans.	Rose, Tom Kirke, D.Sc., 9, Royal Mint, E.
June 18, 1896		Rosenblum, S. G., F.I.C., 50, Albert-mansions, South Lambeth- road, S.E.
May 7, 1896		Rosenheim, Otto, Ph.D., 68, Belsize-park-gardens, N.W.
Mar. 4, 1897		Rosling, Edward, Melbourne, Chelmsford
Feb. 15, 1894		Ross, Arthur, 1, Glengall-road, Old Kent-road, S.E.

Date of Election		
Feb. 17, 1870		Ross, Lewis Buttle, Driffield
Dec. 15, 1881		Ross, Rev. Henry, LL.D., Dallas House, Lancaster
May 7, 1896		Ross, R. St. G., 30, Britannia-square, Worcester
June 18, 1891	Proc.	Rossiter, Edmund Charles, Sunnysfield, Vicarage-road, Langley, Birmingham
Feb. 20, 1896		Rostron, H., B.Sc., 70, Davenport-street, Bolton
Feb. 18, 1892		Rothewell, C. F. Seymour, 88, George-street, Moss Side, Manchester
Feb. 15, 1894		Rouillard, Richard A., 2, Springfield-road, Wimbledon, S.W.
Dec. 5, 1895		Round, W., 10, Northampton-street, Birmingham
Dec. 19, 1872		Routledge, Robert, B.Sc., Genside, Hexham
Feb. 15, 1894		Rowntree, Walter Smithson, B.Sc., Sidcot School, Somerset
Mar. 20, 1862		Royle, Thomas, 329, Upton-lane, Forest Gate, E.
Feb. 15, 1872	Trans.	Ruffle, John, Gnoll Brook, Neath, South Wales
Dec. 5, 1895		Rugginz, W. A., 11, Selborne-road, Grange Estate, Ilford
Jan. 17, 1889	Trans.	Ruhemann, Siegfried, Ph.D., M.A., Gonville and Caius College, Cambridge
Feb. 15, 1883		Rumble, Charles, 9, Sangora-road, New Wandsworth
Feb. 6, 1890		Russell, Edward, 36, Lucerne-road, Highbury Park, N.
Dec. 3, 1896		Russell, William, c/o The Gold and Silver Extraction Co., Limited, 208-210, McPhee Buildings, Denver, Colorado, U.S.A.
Mar. 3, 1851	Trans.	Russell, W. J., Ph.D., F.R.S., 34, Upper Hamilton-terrace, St. John's-wood, N.W.
Feb. 20, 1896		Rutter, T. F., B.Sc., The Huish School and Myrtle Cottage, Trinity, Taunton
June 7, 1894		Ryce, George, B.A., Rathmore-place, Cork
Feb. 16, 1870		Rylands, Thomas Glazebrook, F.L.S., Highfields, Thelwall, near Warrington
June 7, 1888		Sach, A. J., Technical School, Goulburn, N.S.W.
June 18, 1868		Sadler, S. A., Dr., Cleveland Chemical Works, Middlesborough
May 4, 1882		Sadtler, Samuel P., Ph.D., 145, North 10th-street, and 1042, Drexel-buildings, Philadelphia, U.S.A.
Feb. 20, 1896		Sage, C. E., 82, Hanley-road, Crouch End, N.
June 19, 1879	Trans.	Sakurai, J., Science College, Imperial University, Tokyo, Japan
Feb. 19, 1880		Salamon, Alfred Gordon, 27, Holland-park, W.
May 4, 1876		Salomons, Sir David Lionel, Broomhill, Tunbridge Wells; and Berkeley Chambers, 13, Bruton-street, Hyde-park, W.
April 16, 1863		Salt, Henry, M.D.C.M., F.R.G.S., Inglewood, Great Malvern
Feb. 17, 1859		Salter, Thomas W., 15, Belle Vue, West-hill, Hastings
June 25, 1871		Salter, Mortyn John, Northcote, Beaconsfield-road, New Southgate
Feb. 20, 1896		Salt, A. P., Sunnyside, Pinner-road, Harrow

Date of Election.

May 4, 1882		Samuel, W. Cobden, Wilton Lodge, 237, Norwood-road, West Norwood, S.E.
Mar. 3, 1870		Sandberg, C. P., 19, Great George-street, Westminster
Feb. 18, 1892		Sanderecock, Thos. J. Buckler, Sidcup College, Sidcup, Kent
Dec. 6, 1888		Sanderson, John, P.O. Box 84, Middlesborough, Kentucky, U.S.A.
Nov. 16, 1882		Sanford, P. Gerald, Laboratory, 20, Cullum-street, E.C.
Dec. 4, 1890		Saniter, Ernest Henry, Laboratory, Wigan Coal and Iron Co., and 16, Swinley-road, Wigan
Dec. 3, 1891		Sanyal, Abhayacharan, M.A., Professor of Physical Science, Queen's College, Benares, N.W.P., India
Dec. 15, 1892		Surbadhicary, Satya-prasad, 1, College-street Calcutta
June 17, 1886		Saunders, Prof. William, Experimental Farm, Ottawa, Ontario, Canada
Dec. 3, 1896		Saville, A. E., Gasworks, Colwyn Bay, Wales
Feb. 6, 1890		Sayers, William Charles, 63, High-street, Lewisham, S.E.
Dec. 3, 1885		Scammell, Luther R., 42-4, King William-street, Adelaide, South Anstralia
June 21, 1877		Searf, Sydney Isaac, F.I.C., City of London College, White-street, Moorfields, E.C.; and 75, Oxford-road, Islington, N.
Dec. 7, 1893		Schidrowitz, Philip, Ph.D., 102, Oxford-gardens, Notting Hill
Dec. 6, 1888		Schieffelin, William Jay, 841, Southern-boul., New York, U.S.A.
Dec. 15, 1892	Trans.	Schloesser, Augustus, Ph.D., Storey Institute, Lancaster
Feb. 18, 1892		Schofield, James Alexander, University of Sydney, New South Wales
Mar. 15, 1842	Trans.	Schunck, Edward, Ph.D., F.R.S., Oaklands, Kersal, Manchester
Dec. 6, 1894		Scorer, A. G. Flaxmoor, Caston, Attleborough, Norfolk
Feb. 20, 1896		Scotland, P. B., Airdrie Academy, Airdrie, N.B.
Dec. 18, 1879	Trans.	Scott, Alexander, M.A., D.Sc., Davy-Faraday Research Laboratory, 20, Albemarle street, W.
April 17, 1890		Scott, Ernest George, 67, Lord-street, Liverpool
Mar. 3, 1887		Scrutton, W., Cue, W. Australia
Mar. 1, 1883	Proc.	Scudder, Frank, 44, Mosley-street, Manchester
Dec. 3, 1896		Seahooke, H. C., Laboratory, The Brewery, Reading.
May 7, 1891		Searl, Albert, Montrena, Victoria-road, Sidcup
Nov. 20, 1890		Seaton, Edward C., M.D., The Limes, 56, North Side, Clapham Common, S.W.
June 21, 1888		Seely, Herbert W., 11, Corn-market, Halifax
Dec. 15, 1892	Trans.	Sell, William James, Univ. Chem. Laboratory, Pembroke-street, Cambridge
April 15, 1875		Sellon, J. Scudamore, The Hall, Sydenham, S.E.; and 78, Hatton-gardens, E.C.
Mar. 4, 1875	Trans.	Senier, Alfred, Prof., M.D., Ph.D., Queen's College, Galway
June 21, 1887		Senier, Harold, Braybrook Lodge, Harrow

Date of Election.		
June 15, 1893		Sessions, Wilfred, B.Sc., Leighton Park School, Reading
May 7, 1896		Severn, W. D., West End Pathological Laboratory, 55, Weymouth-street, W.
Jan. 20, 1870	Trans.	Seward, Henry, c/o Messrs. J. B. Freeman, Sons, and Co., Wandle Colour Works, Wandsworth, S.W.
Feb. 19, 1874		Sexton, A. Humboldt, F.I.C., F.R.S.E., Professor of Metallurgy, Metallurgical Department, Andersonian-buildings, 204, George-street, Glasgow
Dec. 5, 1895		Seyler, C. A., 31, Windsor-terrace, Swansea
June 20, 1880		Shadwell, J. E. L., Meadowbanks, Melksham, Wilts
Feb. 20, 1873		Shapleigh, Waldron, Welsbach Incandescent Gas Light Co., Factory, Gloucester City, New Jersey, U.S.A.
Dec. 7, 1893		Shapley, Frederick, c/o Messrs. L. Bergen and Sons, 248, Front-street, New York
June 4, 1874		Sharman, William, 247, Mare-street, Hackney, N.E.
June 18, 1835		Sharp, James, The Towers, Low Moor, near Bradford
Feb. 21, 1895		Sharrott, T. C., Chestnut House, Tamworth
Dec. 15, 1892		Shaw, G. Arthur, 45, St. Petersgate, Stockport
May 16, 1895	Trans.	Shaw, G. E., 9, Basing-road, Westbourne-park, W.
Feb. 6, 1890	Trans.	Shaw, Saville, Durham College of Science, Newcastle-upon-Tyne
June, 16, 1887		Sheard, John T., Birley Mount-villas, Wadsley-bridge, near Sheffield
April 4, 1889		Shegog, Thomas Alexander, 28, Omsbersley-road, West Park, Newport, Mon.
Feb. 17, 1876	Trans.	Shenstone, W. A., Clifton College, Bristol; and Glenfarg Villa, Percival-road, Clifton, Bristol
May 21, 1874		Shepherd, H. H. B., Northote, Mount Pleasant-lane, Upper Clapton, N.E.
June 18, 1891	Trans.	Shields, John, Ph.D., D.Sc., 79, Balmoral-road, Willesden Green, N.W.
Dec. 3, 1896		Shimomura, Kotaro, Prof., Dotemachi, Kioto, Japan.
June 7, 1894		Shorthouse, H. S., 47, Pershore-road, Birmingham
Nov. 18, 1886		Shutt, Frank T., M.A., Experimental Farm, Ottawa, Canada
April 17, 1890		Shuttlewood, W. Brewin, 8, Clifton-road, Crouch End, N.
June 7, 1894		Shuttleworth, E. B., Prof., 220, Sherborne-street, Toronto
May 16, 1839		Sibson, Alfred Edward, 3, Osborne-road, Buckhurst Hill, Essex
Dec. 15, 1859		Sibson, Alfred, 23, St. Mary Axe, E.C.
Nov. 29, 1874	Trans.	Siebold, Louis, Broomville-avenue, Sale, near Manchester
Dec. 2, 1886		Silvester, Harry, 78, Holyhead-road, Handsworth, Birmingham
Dec. 3, 1885		Sim, James, 77, Dee-street, Aberdeen
April 4, 1889		Simmonds, Henry, Gas Works, Colue, Lancashire
April 21, 1887		Simmons, L. Owen, 64, Somerleyton-road, Brixton, S.W.
June 20, 1895		Simons, A. J., c/o M. Simons, 31, Little Britain, E.C.

Date of Election.

Feb. 20, 1896		Simpson, A. M., 4, Kitto-road, St. Catherine's-park, S.E.
1857	Trans.	Simpson, Maxwell, M.D., F.R.S., 9, Barton-street, West Kensington
May 29, 1886		Simpson, William Selby, 95, Darenth-road, Stamford Hill, N.
Dec. 7, 1893	Trans.	Sims, W. Edgar, M.Sc., Harpourey Chemical Works, Manchester
May 16, 1889		Singer, Ignatius, The Poplars, Chapel-street, Calverley, Yorks.
Feb. 20, 1896		Sircar, Amrita Lal, 51, Sankaritola, Calcutta
April 15, 1880		Skelton, J. R., Idle Hour, Thorpe St. Andrew, Norwich
Feb. 2, 1888	Trans.	Skinner, Sidney, M.A., The Cavendish Laboratory, Cambridge
Feb. 18, 1892		Skurray, Thomas, United Breweries, Abingdon, Berkshire
April 17, 1879		Slater, Charles, 81 St. Ermin's-mansions, Westminster
April 15, 1880	Trans.	Slater, Harold H., Laboratory and Cement Testing Office, Grays, Essex
Dec. 5, 1878		Slatter, George W., A.R.C.S., F.I.C., 12, Bromley-street, Shipley, Yorkshire
April 4, 1889		Slater, John W., 47, Clarisbrook-road, Walthamstow
May 16, 1895		Slocum, F. L., Linden-avenue Corner, Reynolds-street, Pittsburgh, Pa.
Feb. 5, 1863	Trans.	Smee, A. Hutchinson, The Grange, Hackledge, Carshalton, Surrey
Dec. 16, 1875		Smetham, Alfred, Analytical Laboratory, Cereal Chambers, 16, Brunswick-street, Liverpool
June 21, 1883		Smith, Adolphe, 4, Barclay-road, Walham Green
April 17, 1890	Trans.	Smith, Alexander, Ph.D., B.Sc., Univer. Chicago, Chicago, U.S.A.
Feb. 16, 1888		Smith, Angus, 10, Ardgowan-street W., Greenock, N.B.
Dec. 15, 1881	Trans.	Smith, Bernard E., Alkali Acts Department, Local Government Board, Whitehall, S.W.; and 48, Percy-park, Tynemouth
Dec. 6, 1894	Trans.	Smith, Claude, Feruside, Haveringatte Bower, Romford, E.
Feb. 21, 1884		Smith, Edgar Francis, 35, Amptill-square, Hampstead-road, N.W.
Dec. 9, 1869		Smith, Edward, Dukes, Bradninch, near Cullompton, Devon
June 7, 1894	Trans.	Smith, Ernest A., Metallurgical Laboratory, Royal College of Science, South Kensington
Nov. 20, 1892		Smith, Fred., P.O. Box 1324, Johannesburg, S.A.R.
April 2, 1874		Smith, George, Nobel's Explosives Co., Polmont Station, Scotland
Dec. 20, 1883		Smith, George, 282, Friern-road, East Dulwich, S.E.
June 18, 1896		Smith, G. E. Scott, 67, Surrey-street, Sheffield
Feb. 18, 1892		Smith, George P. Darnell, 80, Woodland-road, Bristol
Feb. 20, 1896		Smith, H. G., The Technological Museum, Sydney
Feb. 6, 1890		Smith, Harry Wood, B.Sc., Messrs. May and Baker, Garden Wharf, Church-road, Battersea
Mar. 16, 1878		Smith, H. R., 1, Aubert-park, Highbury, N.
May 5, 1892		Smith, John Meadows, Laboratory, 66, College-street, Chelsea, S.W.
Dec. 18, 1879		Smith, John William

Date of Election.

Dec. 5, 1895		Smith, Matthew, B.A., Glenholme, Bishop Auckland, co. Durham
Feb. 19, 1891		Smith, R. Greig, Durham College of Science, Newcastle-on-Tyne
Feb. 16, 1888		Smith, Sam, 15, Springfield-road, Swindon
Nov. 18, 1886		Smith, Sidney, 35, Ampthill-square, Hampstead-road, N.W.
Feb. 3, 1876		Smith, W. A., M.A., M.B. Oxon, M.R.C.S. Eng., Newport, Essex
Dec. 20, 1866	Trans.	Smith, Watson, 34, Upper Park-road, Haverstock Hill, N.W.
Dec. 20, 1883	Trans.	Smithells, Arthur, Prof. B.Sc., The Yorkshire College, Leeds
Dec. 18, 1873		Smyth, John, M.A., Milltown, Bantridge, Ireland
Mar. 3, 1887	Trans.	Snape, Henry Lloyd, Prof., Chemical Laboratories, University College of Wales, Aberystwith
Dec. 3, 1896		Sodeau, W. H., B.Sc., 25, Shore-road, South Hackney, N.E.
Feb. 3, 1887		Sohn, Charles E., F.I.C., 22, Southampton-row, W.C.
June, 18, 1891		Solomon, Frank Oakley, 36, St. Mary's-place, Newcastle-on-Tyne
Dec. 17, 1874	Trans.	Sonstadt, Edward, Church Field, Cheshunt, Herts
Dec. 18, 1884	Trans.	Sorabji Bomanji, Khan Bahadur, Ph.D., C.E. (Bombay) Assoc., M.I.C.E. (Lond.), 8, Sleater-road, Bombay
June 15, 1893		Sorrell, Henry Thomas, Holly Lodge, Millbrook-road, Southampton
May 6, 1875		Southall, Alfred, Garrick House, Richmond Hill, Edgbaston
Mar. 4, 1897		Southerden, Frank, 75, Barry-road, Dulwich, S.E.
June 21, 1883		Soward, Alfred W., 28, Therapia-road, Honor Oak, S.E.
Dec. 15, 1892		Speakman, Charles, Rosehaugh, Clitheroe, Lancashire
Feb. 21, 1889		Speakman, James, Penhold, Post Office, Calgary, Alberta, Canada
Feb. 1, 1883		Spencer, Ernest Samuel, Arborfield, Wimbledon Park
April 4, 1878		Spencer, James, B.Sc., 38, Ash-grove, Bradford
Mar. 4, 1886		Spencer, Richard, Woodside, Croslands Park, Barrow-in-Furness
Feb. 6, 1879		Spencer, Samuel, 21, St. George's-road and Castle Brewery, Castle-road, Southwark, S.E.
June 16, 1887		Spencer, W. Shelley, Lyndene, Darley, Farnworth, near Bolton
June 7, 1894		Spenser, John George, M.D., Ph.D., Prof., Western Reserve University, 370, Central-avenue, Cleveland, Ohio, U.S.A.
Feb. 3, 1859	Trans.	Spiller, John, 2, St. Mary's-road, Canonbury, N.
Jan. 15, 1863		Spiller, William, Atlas Dye Works, Hackney-wick, E.
June 18, 1885		Spilsbury, James, Mayfield, Mayfield-road, Moseley, Birmingham
June 4, 1885		Spottiswoode, W. Hugh, Balliol College, Oxford; and 6, Middle New-street, E.C.
Feb. 18, 1892		Spray, Henry John, c/o Messrs. Hopkins and Williams, Bridge-fields, Wandsworth, S.W.
Dec. 1, 1864	Trans.	Sprengel, Hermann Johann Philipp, Ph.D. (Heidelb.) F.R.S., Royal Prussian Professor (titular), Savile Club, 107, Piccadily, W.

Date of Election.

Mar. 16, 1895		Squance, T. C., M.D., M.S., L.S.Sc., F.R.M.S., F.R.M. St. S., 15, Grange-crescent, Sunderland
May 4, 1882		Squire, P. Wyatt, 413, Oxford-street, W.
Feb. 4, 1858	Trans.	Squire, W. Stevens, Ph.D., Clarendon House, St. John's Wood-park, N.W.
Feb. 18, 1892		Squires, Alfred James, 84, Derby-road, Farnworth, Widnes, Lancs.
May 5, 1892		Stables, William Herbert, Rev., B.A.
June 21, 1877		Stacey, Henry George, 300, High Holborn, W.C.
Mar. 4, 1897		Stainer, W. J., B.A., 3, Havelock-road, Stanford-avenue, Brighton
Dec. 18, 1879	Trans.	Stallard, George, M.A., Horton Crescent, Rugby
April 21, 1859	Trans.	Stanford, Edward Charles, Glenwood, Dalmauir, Dumbartonshire
Mar. 17, 1887		Stanger, W. Harry, Chemical Laboratory, Broadway, Westminster
Feb. 3, 1887		Stansell, Lionell W., 4, Albion-place, Maidstone, Kent
May 16, 1895		Stansfield, A., B.Sc., Aldersyde, Hainault-road, Leytonstone
Dec. 3, 1835		Staples, Henry J., Spondon, Derby
Dec. 15, 1870		Starey, Arthur J., 18, Ashley-road, Hornsey-rise, N.
Dec. 15, 1870	Trans.	Stark, J. Fleming, 31, Highfield South, Rock Ferry, Birkenhead
Mar. 16, 1876		Starling, J. H., 32, Craven-street, Strand, W.C.
May 7, 1896		Stead, J. C., Mitre Chemical Works, Cordova-road, Bow, E.
Nov. 16, 1882	Trans.	Stead, J. E., Redcar, Middlesborough
May 4, 1882		Stebbins, James H., jun., Ph.D., 114, Pearl-street. New York
May 7, 1835		Steel, Robert Elliot, County School, Northampton
June 7, 1894		Steel, Robert W., Wedderburn, Paisley
Dec. 5, 1889		Steel, Sydney, 26, Somerset-street, Portman-square, W.
Dec. 4, 1890		Steel, Thomas, c/o Colonial Sugar Refining Co., Sydney, N.S.W.
Dec. 18, 1884		Steele, Robert, 8, Adelaide-square, Bedford
May 5, 1892	Trans.	Stenhouse, James, Elm-row, Lasswade, Midlothian, N.B.
Jan. 17, 1884		Stenhouse, Thomas, Townhead, Rochdale
Dec. 5, 1895	Trans.	Stevens, F. R., c/o Messrs. Idris, Pratt-street, Camden Town, N.W.
April 15, 1880		Stephens, Henry Charles, M.R. Inst., Avenue House, Finchley
Feb. 21, 1895		Stephenson, Herbert F., 202, Barry-road, E. Dulwich, S.E.
Dec. 3, 1835		Stephenson, Stephen, 98, Kensington, Liverpool
Dec. 3, 1891	Trans.	Stephenson, Thomas, Victoria House, Byculla, Bombay
Dec. 6, 1838	Trans.	Stern, Arthur Landauer, D.Sc., F.I.C., 170, Ashby-road, Burton-on-Trent
Dec. 15, 1881		Steuart, Daniel Rankin, Osborne Cottage, Broxburn, Linlithgowshire
June 18, 1896		Steuart, D. Stuart Spens, B.Sc.
Mar. 4, 1897	Trans.	Stevens, H. P., B.A., 14, Lower Sloane-street, Chelsea, S.W.
Feb. 18, 1864		Stevenson, Thomas, M.D., Sandhurst Lodge, 45, Gresham-road, Brixton, S.W.
Feb. 6, 1879		Stevenson, William, 95A, Southwark-street, S.E.

Date of Election.

June 20, 1872		Stewart, Walter, 1, Murrayfield-gardens, Edinburgh
June 21, 1866		Stock, W. F. K., 5, Dixon-terrace, Darlington
June 18, 1874		Stocks, Frederic, Snead's Green House, Droitwich, Worces- tershire
Nov. 17, 1887		Stocks, Herbert B., c/o Messrs. Day and Martin, Borough-road, S.E.
May 3, 1894		Stoddart, Frederick Wallis, Grafton Lodge, Sneyd Park, Bristol
April 17, 1879	Trans.	Stokes, A. W., Vestry Hall, Paddington
Dec. 18, 1873		Stone, Edward Daniel, Rose Lea, Alderley Edge, Cheshire
April 17, 1890		Stone, Frederick Richard M., 58, Upper Parliament-street, Liverpool
Dec. 5, 1895		Stone, George, Standard Brewery, Sydney, N.S.W.
Dec. 2, 1875		Stone, J. Harris, M.A., F.L.S., Barrister-at-Law, 4, Temple, E.C.
April 17, 1879		Stone, William, M.A. Cantab, F.L.S., Oxford and Cambridge, Garrick, and Union Clubs, and D. 6, The Albany, Piccadilly
May 7, 1891		Storey, James Ashburner, B.Sc., Matale, Ceylon
June 19, 1884		Stormouth, Thomas, Athol House, Clarence-road, St. Thomas, Exeter
Feb. 3, 1887		Strangman, J. Pim, 38, Rue Desbardes, Valmore, Passay, Paris
May 7, 1885	Trans.	Stuart, Charles M., M.A., St. Dunstan's College, Catford, S.E.
Dec. 7, 1893		Styles, R. Curling, Knockhall, Greenhithe, Kent
Dec. 4, 1890	Trans.	Sudborough, J. Joseph, Ph.D, D.Sc., University College, Not- tingham
Dec. 5, 1878	Trans.	Suguiira, Shigetake, care of Tokio Chemical Society, Imagawakoji 1, Tokio, Japan
Mar. 4, 1897		Sumner, Leonard, B.Sc., Butt Hill, Prestwich, near Manchester
Feb. 16, 1888		Sumner, Robert Mason, c/o Messrs. Parke, Davis and Co., Detroit, Michigan, U.S.A.
Feb. 3, 1887		Sutherland, D.A., F.I.C., 28, Victoria-street, Westminster, S.W.
Feb. 21, 1884		Sutton, C. W., 19, Henley-road, Ipswich
April 19, 1860		Sutton, F., Laboratory, Bank Plain, Norwich
Mar. 4, 1886		Sutton, F. Napier, 6, Grosvenor-gardens, Willesden Green
June 3, 1875		Swan, Joseph Wilson, M.A., F.R.S., 58, Holland-park, W
June 20, 1889		Swan, Robert, M. W., 15, Walmer-crescent, Glasgow
May 3, 1894		Swinburne, James, 66, Victoria-street, S.W.
Dec. 5, 1889		Sworn, Sidney Augustus, M.A., The New Municipal Technical School, Gravesend
Feb. 18, 1892		Sykes, James, 76, Lockwood-road, Huddersfield
Feb. 19, 1891		Sykes, M. Carrington, L.P.H. Lond., L.R.C.P. Lond., M.R.C.S. Eng., L.S.A. Lond., Sykeshurst, Barnsley, Yorks.
May 16, 1889		Sykes, Walter J., M.D., 59, Friend's-road, Croydon
Feb. 19, 1891		Symes, K. Edward, 95, Lodge-road, The Avenue, Southampton

Date of Election.

June 17, 1880		Symons, Brenton, 5, Kew Gardens-road, S.W.
Dec. 17, 1874	Trans.	Symons, William Henry, M.D. (Brux.), D.P.H. (Oxon.), M.R.C.S. Eng., F.I.C., Medical Officer of Health's Department, Guildhall, Bath
Feb. 17, 1881	Trans.	Takamatsu, T., Engineering College, Imperial University, Tokio, Japan
Feb. 3, 1887	Trans.	Takamine, Jokichi, 6641, Woodlawn-avenue, Chicago, U.S.A.
Feb. 15, 1894		Tanner, Alf. E., Westminster Hospital, S.W.
Dec. 4, 1890		Tate, Francis Henry, 9, Hackins Hey, Liverpool
June 16, 1881	Trans.	Tate, George, Ph.D., 11 and 12, London and Lancashire Chambers, 45A, Dale-street, Liverpool
Dec. 18, 1884		Tate, Walter, The Woodlands, Tiverton-on-Avon, Bath
May 15, 1890		Tate, William, Civil Engineering College, Sibpur, Calcutta
Dec. 5, 1867		Tatlock, Robert R., Novara, Stirling
Dec. 6, 1894		Taylor, Albert, Technical School, Stockport
Dec. 2, 1875		Taylor, Andrew, 11, Lutton-place, Edinburgh
Dec. 7, 1882		Taylor, G. Midgley, 27, Great George-street, Westminster
June 7, 1894		Taylor, Herbert J., 9, Portland-villas, Bath-street, Dewsbury
June 17, 1880		Taylor, James, B.Sc., Government metallurgical works, Clyde, New South Wales
June 18, 1891		Taylor, John, 15, Lucius-street, Torquay
April 19, 1888		Taylor, John G., 16, Trinity-street, Stockton-on-Tees
Jan. 15, 1874	Trans.	Taylor, R. L., 37, Mayfield-road, Whalley Range, Manchester
Dec. 6, 1888		Taylor, William, China Sugar Refining Co., East Point, Hong Kong
April 4, 1878		Tcherniac, Joseph, Ph.D., Thalstrasse 1, Freiburg, Briesgau, Germany
April 17, 1879	Trans.	Teed, Frank L., D.Sc., 15, Victoria-street, S.W.
May 1, 1877		Terrill, William, 42, St. George's-terrace, Swansea
May 3, 1894		Terry, Edwin, 374, Brixton-road, S.W.
Feb. 15, 1881		Tervet, Robert, 54, Penshurst-road, South Hackney, E.
Feb. 16, 1893		Thackrah, James R., M.A., Ph.D., 5, The Crescent, Hipperholme, Halifax
May 16, 1895		Theodosius, A. F., B.A., University Coll., Oxford
Nov. 17, 1859		Thomas, Andrew, c/o M. C. Neville, Esq., 9, Hendley-street, Adelaide, South Australia
Dec. 7, 1871		Thomas, Charles, Woodcote, Stoke Bishop
Mar. 5, 1874		Thomas, Harry Edgecombe, Rockleaze Point, Clifton, Bristol
Feb. 18, 1875	Trans.	Thomas, Joseph William, Drumpellier, Brunswick-road, Gloucester
Feb. 5, 1863		Thompson, Beeby, 55, Victoria-road, Northampton
Dec. 3, 1896		Thompson, Charles, B.Sc., Grammar School, Coatham, Redcar
Mar. 4, 1886	Trans.	Thompson, Claude M., M.A., University College, and 38, Park-place, Cardiff
June 7, 1894		Thompson, Edward Cumming, 48, Kestrel-ayenue, Herne Hill, S.E.

Date of Election.

June 15, 1893		Thompson, Frank Ernest, 97, Murdock-road, Handsworth, Birmingham
May 4, 1893		Thompson, George R., The Laboratory, 57, Dock-street, Newport, Mon.
Mar. 4, 1897		Thompson, Harry, Plaka, Milo, Greece
Dec. 16, 1886		Thompson, W. Phillips, 95, Shrewsbury-road, Cloughton, Birkenhead
Dec. 17, 1885	Trans.	Thomson, Andrew, D.Sc., 10, Pitcullen-terrace, Perth
Nov. 2, 1876		Thomson, George C., 1, Thornwood-terrace, Partick, Glasgow
April 15, 1858	Trans.	Thomson, John, Gwydor Villa, Elmers End, Beckenham
Jan. 18, 1872	Trans.	Thomson, John Millar, Prof., F.R.S., King's College, W.C.; and 85, Addison-road, W.
Jan. 18, 1872		Thomson, William, Royal Institution Laboratory, Manchester
May 16, 1895		Thomson, W. T., Offord-villas, Walham Abbey
May 7, 1891		Thonger, C. G. Freer, M.R.A.C., Colonial College, Hollesley Bay, Suffolk
Dec. 3, 1885		Thorne, Edward E. H., care of H. E. Thorne, Esq., Bridgetown, Barbadoes, West Indies
Feb. 16, 1882	Trans.	Thorne, Leonard T., Ph.D., 8, Dynevor-road, Richmond
Nov. 20, 1890		Thornley, J., Brooks, jun., c/o Felton, Grimwash, and Co., Jeffcott-street, Melbourne, Australia
May 16, 1895		Thornton, A., M.A., 67, St. Mary's-terrace, Manningham
Dec. 3, 1891		Thorp, Walter, B.Sc., Analytical Laboratory, Limerick
Feb. 1, 1866	Trans.	Thorp, William, B.Sc., 22, Sinclair-gardens, West Kensington
Feb. 16, 1871	Trans.	† Thorpe, T. E., Ph.D. (Heid.), B.Sc. (Vict.), D.Sc. (Dubl.), LL.D. (Glas.), F.R.S., Inland Revenue, Somerset House, W.C.
Dec. 7, 1893	Trans.	Thorpe, Jocelyn Field, Ph.D., Owen's College, Manchester
June 7, 1894		Thudichum, George Dupré, Montrose, Dorset-road, Merton Park, Wimbledon
Dec. 20, 1880	Trans.	Thudichum, John L. W., M.D., 11, Pembroke-gardens, W.
Dec. 2, 1860		Thwaite, B. H., 29, St. George-street, Westminster
Dec. 5, 1895		Tibbals, W. I., 93, Cass street, Detroit, Mich., U.S.A.
Feb. 19, 1863	Trans.	Tichborne, C. R. C., Ph.D., 15, North Great George-street, Dublin
Mar. 6, 1897	Proc.	Tickle, Thomas, 4, Pakenham-street, W.C.
Mar. 17, 1881	Trans.	Tiemann, Ferdinand, Prof., Dr., Parkstrasse, Wannsee, by Potsdam
June 1, 1865	Trans.	† Tilden, William A., Prof., F.R.S., 9, Ladbroke-gardens, W.
Dec. 5, 1889	Trans.	† Tingle, J. Bishop, Ph.D., Chemical Department University of Pennsylvania, Philadelphia, U.S.A.
May 7, 1891		Tocher, James Fowler, A.I.C., 1, Chapel-street, Peterhead
Feb. 21, 1884	Trans.	† Tompson, Frederick William, 1, St. Mildred's-road, Ramsgate
June 21, 1877		† Toms, Frederick Woodland, F.I.C., Official Analyst, Jersey

† Longstaff Medallist, 1881.

Date of Election.

Jan. 15, 1855	Trans.	Tookey, Charles, Museum of Practical Geology, Jermyn-street, S.W., and Nelson's Hotel, Great Portland-street, W.
Dec. 3, 1868		Tosh, Edmund G., The Lund, Ulverston, Lancashire
Feb. 16, 1893		Towers, John William, Brantwood, Allerton, Liverpool
Feb. 2, 1888		Townsend, Charles F., 31, Elms-road, Clapham Common, S.W.
June 6, 1887		Traphagen, Dr. Frank W., College of Agriculture, &c., Bozeman Montana, U.S.A.
Feb. 18, 1892	Trans.	Travers, Morris W., 2, Phillimore-gardens, Kensington, W.
May 16, 1895		Trehanne, F. G., Wrangbrook, Llanishen, near Cardiff
Feb. 15, 1894		Trench, George, Cotton Powder Co., Faversham
Mar. 15, 1888		Trewby, Herbert, Radnor House, Ribblesdale-road, Hornsey, N.
June 16, 1881		Trigger, Oliver, Chemical Dept., Royal Arsenal, Woolwich
Dec. 4, 1873		Truman, Edgar, M.D., 9, Watcombe-circus, Carrington, Nottingham
Dec. 5, 1889		Tucker, Willis G., M.D., Medical College, Albany, New York, U.S.A.
May 7, 1896		Tuckett, J. E. S., M.A. Cantab, Eastbourne College, Eastbourne
May 5, 1892		Tuer, Arthur Holt, Thornhill, Wigan, Lancashire
Mar. 4, 1897		Turnbull, Andrew, Daldowie, Broomhouse, near Glasgow
Dec. 2, 1886		Turner, Arthur, L.D.S. Ed., The Limes, Aylesbury
Feb. 20, 1896		Turner, B. B., B.Sc., Fraulien Scholte, Karspüle, 16 D. Göttingen, Germany
Dec. 6, 1888		Turner, Charles, 225a, Oxford-street, Manchester
Feb. 1, 1883	Trans.	Turner, Thomas, Ravenhurst, Rowley Park, Stafford
Feb. 21, 1889	Trans.	Turpin, George Sherbrooke, M.A. (Cantab), D.Sc. (Lond.), Schoolhouse, Swansea
Feb. 2, 1871		Tustin, John Robt., F.R.G.S., Albion House, The Marina, Deal
Feb. 2, 1888	Trans.	Tutton, Alfred E., 17, Bardswell-road, Oxford
June 19, 1879		Tweedie, George R., 8, Victoria-parade, East Cliff, Ramsgate
May 5, 1892		Tweedie, Thomas Shortridge, The Moat, Annan
Feb. 17, 1876		Typke, P. G. W., Ravenhurst, New Malden
Dec. 7, 1876		Tyrer, Thomas, Stirling Chemical Works, Abbey-lane, Stratford
Dec 3, 1885		Tyson, Thomas B., 1, New China Bazaar-street, Calcutta
April 6, 1876		Udall, Thomas Bertram, Newcastle-under-Lyme, Staffordshire
Nov. 16, 1865		Umney, Charles, 50, Southwark-street, S.E.
Feb. 16, 1893	Trans	Umney, John C., 50, Southwark-street, London, S.E.
Feb. 21, 1889		Underhill, Thomas J., 6, The Terrace, Royal Victoria Yard, Deptford, S.E.
Mar. 4, 1897		Unwalla, R. N., Medical Dept., Bhavnagar, Kathiawâr, India
Mar. 16, 1882		Vacher, Francis, 7, Shrewsbury-road, Oxtou, Birkenhead
Mar. 6, 1890		Valentin, Basil William, Messrs. Buckley Bros., Brewery, Llanelly, S. Wales

Date of Election.

Dec. 1, 1887		Vargas, Vergara J. M., 237 P.O. Box, Bogota, Columbia, S. America
Mar. 1, 1883		Vasey, S. A., Kingsthorpe, Lower Park, Loughton, Essex
Dec. 7, 1882		Vasey, Thomas E., P.O., Box 1149, Montreal, Canada
June 15, 1893		Vautin, Claude T. J., Bevois House, 28, Basinghall-street, E.C., and 3, Upper Hamilton-terrace, N.W.
Dec. 6, 1894		Vaux, Cuthbert, 11, Thornhill-park, Sunderland
April 17, 1879	Trans.	Veley, Victor H., M.A., F.R.S., 22, Norham-road, and University Museum, Oxford
Feb. 19, 1891		Velling, F. W. De, B.A., Higher Grade Board School, The Boulevard, Hull
May 6, 1881		Venable, Frank P., Ph.D., Chapel Hill, North Carolina
Jan. 18, 1872		Vincent, Charles W., F.R.S.E., F.C.S. of Berlin, Reform Club, Pall Mall, S.W., and Royal Institution, W.
May 16, 1880		Virtue, William, Abbey-street and Waterside Distilleries and Mills, Londonderry
Feb. 21, 1884		Voelcker, Edward William, 22, Tudor-street, Blackfriars, E.C.
Jan. 17, 1884		Voelcker, John A., Ph.D., 20, Upper Phillimore-gardens, Kensington, W.
April 4, 1889		Voss, Walter Arthur, 15, Nicholson-road, Addiscombe, Croydon
Nov. 19, 1885		Vulté, Hermann T., Ph.D., School of Mines, Columbia College, East 49th-street, corner of 4th-avenue, New York
Feb. 6, 1890		Wade, John, B.Sc. (Lond.), Wyvenhoe, Purley, and Guy's Hospital, S.E.
Dec. 6, 1894		Wagner, W. G., Glyndhurst, Ealing Common, W.
April 17, 1884		Wainwright, J. Howard, Ph.D., 22, West 46th Street, New York, City, U.S.A.
Feb. 16, 1893		Wait, Chas. E., Prof., University of Tennessee, Knoxville, U.S., N.A.
May 17, 1888		Wait, Frank Goodell, Geological Survey Department, Ottawa
May 6, 1897		Waite, W. H., B.A., Park-road, Halifax
Dec. 7, 1893		Walden, William Herbert, 57, Felix-road, Brixton, S.W.
Mar. 4, 1897		Walford, S. M., 62, Bloom-street, Stockport
Feb. 16, 1893		Walke, Willoughby, 1st Lieut., Fort Monroe, Virginia, U.S., N.A.
Jan. 16, 1868		Walker, Maj.-Gen. Alexander, C.S.I., R.A., c/o Mrs. Dalzell, Cornwater House, Croxted-road, W. Dulwich, S.E.
Mar. 17, 1881		Walker, Archibald, B.A., 8, Crown-terrace, Dowanhill, Glasgow
June 7, 1894	Trans.	Walker, Chas. H. H., B.A., 28, College Grove-road, Wakefield
Dec. 5, 1889		Walker, Daniel, A.K.C., B.Sc.
Feb. 6, 1890	Trans.	Walker, James, Prof., D.Sc., 8, Windsor-terrace, Dundee

Date of Election.

Feb. 2, 1865	Trans.	Walker, J. F., M.A., 45, Bootham, York; and Sidney College, Cambridge
April 17, 1890		Walker, James S. H., M.B., C.M., 11, Leopold-street, Nairn
Dec. 6, 1888		Walker, J. T. Ainslie, 2, Victoria-road, New Shoreham, Sussex
Mar. 4, 1897	Trans.	Walker, J. Wallace, M.A., Ph.D., University College, W.C.
Feb. 17, 1881		Walker, Robert William, Wicken Hall, New Hey, near Rochdale
April 17, 1879		Walker, Thomas Hatfield, 1, Picton-place, Newcastle-on-Tyne
Dec. 3, 1896		Walker, W. H., Stafford-street, Willenhall, Staffs.
June 4, 1884		Wallace, Prof. Robert, The University, Edinburgh
Dec. 5, 1878		Waller, Elwyn, Ph.D., 440, 1st-avenue, New York
Mar. 3, 1887		Wallis, Henry Weston, 11, Probyn-road, Tulse Hill, S.W.
Mar. 1, 1883		Walmsley, R. Mullineux, D.Sc., Northampton Institute, St. John Street-road, Clerkenwell, E.C.
Dec. 6, 1888		Walrond, Edward Dalrymple, B.A., North Eastern Counties School, Barnard Castle, Durham
Mar. 20, 1884		Walton, Thomas Ulrick, B.Sc., F.I.C., Colonial Sugar Refinery Co., Sydney, New South Wales
April 21, 1864		Ward, George, Buckingham-terrace, Headingley, Leeds
May 16, 1895		Ward, G. J., Hallam Fields, Ilke-ton
Dec. 3, 1891		Ward, Thomas Armistead, 15, Exchange-street, Blackburn
April 20, 1871		Ward, William, Sheffield Moor, Sheffield
Dec. 4, 1873		Warden, C. J. H., Prof. of Chemistry, Medical College, Calcutta
May 20, 1875		Wardle, Sir Thomas, F.G.S., Leek, Staffordshire
Mar. 19, 1863	Trans.	Warrington, Robert, F.R.S., High Bank, Harpenden, St. Albans
June 15, 1893		Warrington, Edward A., Ph.D., F.I.C., 36, Cannon-st., Birmingham
Dec. 7, 1871		Warner, George Joseph, 41, Albert-road, Widnes
May 5, 1891		Warren, Cyprian A., Messrs. Watney's Brewery, Richmond
Dec. 6, 1894		Warren, W. L., 12, Westland-row, Dublin
Dec. 6, 1888		Warrick, Frederic Walmsley, 7, Portpool-lane, E.C.
Nov. 17, 1887	Trans.	Warrington, Arthur Walley, University Coll. of Wales, Aberystwith
Feb. 21, 1895		Warrington, T. C., 52, Regents-road, Hanley, Staffs.
May 16, 1895		Warwick, A. W., Minn. Mines, Wickes. Mont., U.S.A.
Nov. 16, 1882		Waterfall, Charles J., Marienberg, Somerville-road, Bristol
June 7, 1894		Waterfield, A. Swainson, Grammar School, Bromyard, Worcester
Dec. 6, 1894		Waterhouse, Robert, c/o Messrs. J. Fisher and Sons, Limited, Queen's-road, Bradford, Manchester
April 4, 1889		Waterhouse, Wm. John, B.Sc., Christ Church, Oxford
Mar. 15, 1888		Wates, Edward Arthur, Coromandel Gold Mg. Co., Oorgaum, Mysore
May 4, 1893		Watson, A. Forbes, St. James's Gate, Dublin
Mar. 5, 1885		Watson, Charles, 36 40 Hewitt street, Gaythorn, Manchester
Jan. 18, 1872		Watson, David, D.Sc., The Broughton Copper Works, Salford, Manchester, and Willow Bank House, Kersal Dale. Higher Broughton

Date of Election.	
June 16, 1887	Watson, Frederick Percy, 6 and 7, Bailgate, Lincoln
Mar. 1, 1883	Watson, Thomas Donald, 16, St. Mary's-road, Bayswater, W.
Dec. 3, 1896	Watson, Wm., Rev., M.A., School House, Kingsbridge, S. Devon
Jan. 20, 1876	Trans. Watson, W. H., J.P., Braystones, near Whitehaven
June 21, 1877	Watt, Alexander, c/o Messrs. Macfie and Sons, 34, Moorfields, Liverpool
Mar. 1, 1883	Trans. Watts, Francis, Govt. Laboratory, St. John's, Antigua, W. Indies
Feb. 1, 1872	Trans. Watts, John, D.Sc., Merton College, Oxford
Dec. 5, 1878	Trans. Watts, John I., Fairleigh, Hartford, Cheshire
Dec. 6, 1888	Way, Edward J., F.I.C., Eastleigh Syndicate, Box 84, Keerksdorp, Transvaal, S.A.R.
Mar. 1, 1883	Trans. Webster, Charles Stuart, Malvern House, Redland, Bristol
Mar. 1, 1866	Webster, G. W., 33, Bridge-street-row, Chester
June 21, 1877	Webster, William, Glencot, Blackheath Park, Blackheath, S.E.
April 4, 1889	Weir, P. A., Lieut.-Col., M.B., c/o Messrs. King, King and Co., Bombay
Feb. 16, 1888	Welch, J. Cuthbert, Kaslo, British Columbia
Dec. 7, 1893	Welchman, Frank Ernest, 16, Carlton road, Putney Hill, S.W.
Feb. 19, 1891	Wellington, Stephen N., M.I.C.E., The Bungalow, The Gas Works, Parel, Bombay
June 19, 1884	Trans. Wells, James S. C., Ph.D., Hackensack, New Jersey, U.S.A.
Feb. 6, 1890	Wells, S. Russell, B.Sc., M.B., 29, Devonshire-street, Portland-place, W.
May 6, 1897	Welsh, John, 12A, Sellar-street, Chester
Feb. 18, 1888	Trans. Werner, Emil A., 5, Church-avenue, Rathmines, Dublin
Mar. 4, 1886	Wertheimer, Julius, Prof., B.Sc., B.A., F.I.C., Merchant Venturers' Technical College, Bristol
May 6, 1897	West, C. A., City of London College, and 105, Sydney-street, Chelsea, S.W.
Dec. 6, 1883	Wetzel, Henry A., Messrs. Parke, Davies & Co., Box 470, Detroit, Michigan, U.S.A.
May 5, 1892	Whalley, Lawrence J. de, 26, Park-place, Greenwich, S.E.
June 15, 1893	Whalley, Sydney, 38, Havelock-street, Canterbury
May 3, 1894	Wheeler, H. L., Ph.D., 1812, Prairie-avenue, Chicago
Feb. 16, 1893	Wheeler, William Ernest, 18, Bessborough-gardens, Pimlico, S.W.
Dec. 3, 1896	Whimster, J. I., 9, Corporation-buildings, Dawsonholm, Maryhill, Glasgow
Dec. 3, 1897	Wheelwright, E. W., B.A., Ph.D., The Oaklands, Warley, Oldbury, near Birmingham
April 17, 1879	Whitaker, Thorp, Messrs. Ripley & Sons', Dye Works, Bradford, Yorkshire
Feb. 16, 1893	White, H. C., Prof., Athens, Georgia, U.S.A.

Date of Election.

Dec. 3, 1891		White, Henry, 43, Woodstock-road, Sheffield
Mar. 20, 1862		White, Leedham, 2, Lime-street-square, E.C.
April 4, 1839		White, John Tsawoo, M.A., F.I.C., Treasury Office, Katha, Upper Burmah
May 6, 1897		White, P. T., Horton Field, West Drayton, Middlesex
Dec. 7, 1893		White, William Gilchrist, The Hodge, Broadbottom, near Man- chester
Feb. 5, 1885		Whitehead, Henry H., The Royal Brewery, Brentford
June 18, 1896		Whitehead, James, Roach place, Rochdale
Dec. 5, 1889		Whitehouse, William, Albany House, Bradmore, Wolverhampton
Dec. 15, 1892		Whiteside, John Lowe, 51, Cannon-street, Bolton
April 15, 1886	Proc.	Whiteley, R. Lloyd, 20, Beeches-road, W. Bromwich
Nov. 5, 1862		Whitfield, John, 113, Westborough, Scarborough
June 15, 1893		Whittaker, Thomas, Elwy House, Whalley-road, Accrington
Dec. 5, 1889		Whittam, Matthew, M.A., The Isle of Wight College, Ryde
Dec. 5, 1889		Wigan, Basil P., Rhondda Valley Brewery Co., Treherbert
May 16, 1895		Wigley, H. F. A., Verdin Technical School, Winsford, Cheshire
Dec. 15, 1892		Wigham, F. H., Cherrygarth, Eastmoor-road, Wakefield
Dec. 3, 1896		Wigner, J. H., Ph.D., 44, Avenue de Rumine, Lausanne
Dec. 3, 1896		Wilcox, A. J., St. John's College, Grimsargh, near Preston
May 7, 1891		Wild, John, 28, Hyde-road, Woodley, Stockport
Mar. 4, 1897		Wilderman, Meyer, Ph.D., Davy-Faraday Laboratory, Albemarle- street, W.
June 16, 1881		Wilkes, J. P., 54½, Old Broad-street, E.C.
May 4, 1893		Wilkinson, John, Drighlington, near Bradford
Dec. 17, 1885		Will, Wm. Watson, 1, St. Agnes-place, Kennington Park, S.E.
Feb. 19, 1891		Will, W., Ph.D., Kronprinzen ufer 30, Berlin, N.W.
Jan. 16, 1862	Trans.	Williams, C. Greville, F.R.S., F.I.C., 36, Kenilworth-avenue, Wimbledon
Feb. 21, 1895		Williams, Evan, Gas Works, Rochdale-road, Manchester
Dec. 15, 1892		Williams, John, Government Laboratory, British Guiana
Dec. 5, 1895		Williams, J., B.A., The College, Cheltenham
June 21, 1883	Proc.	Williams, Rowland, Sunny Lea, Aldcliffe-road, Lancaster
June 18, 1891		Williams, Seward W., c/o Seabury and Johnson, 8, Brighton- avenue, East Orange, New Jersey, U.S.A.
Dec. 5, 1872		Williams, Thomas, Chemical Laboratory and Assay Office, A, Queen Insurance-building, 10, Dale-street, Liverpool
Mar. 5, 1885	Trans.	Williams, Walter Collingwood, B.Sc., 68, Grove-street, Liverpool
Feb. 19, 1874	Trans.	Williams, W. Carleton, 23, Broomgrove-road, Sheffield
Dec. 15, 1892		Williams, William, County Offices, Westgate-street, Cardiff, and 63, Plymouth-road, Penarth
Feb. 7, 1878		Williams, W. J., 635, Market-street, Camden, N.J., U.S.A.
Feb. 15, 1894		Williams, W. Lloyd, 10, Miskin-road, Dartford, Kent
May 15, 1848	Trans.	Williamson, A. W., LL D., F.R.S., High Pitfield, Haslemere

Date of Election.

Dec. 4, 1874	Trans.	Williamson, Robert, Low Walker, Newcastle-on-Tyne
Mar. 4, 1886	Trans.	Williamson, Sidney, Cent. Tech. Coll., S. Kensington
May 7, 1896		Wills, E. Chaning, M.A. Cantab., Abbey Park, Keynsham Bristol
Dec. 5, 1872		Wills, Jos. Lainson, c/o Dr. Wyatt, 29, Stone-street, New York
Dec. 5, 1892	Trans.	Wilshire, N. Y. M., Astbury, Regent's Park-road, Finchley, N.
Feb. 5, 1885		Wilson, A. C., Borough Hall, Stockton-on-Tees
Dec. 6, 1894		Wilson, A. Poole, c/o Commissioners of National Education, Education Office, Marlborough-street, Dublin
June 19, 1879		Wilson, Charles J., 14, Old Queen-street, Westminster
Dec. 6, 1894		Wilson, Christopher, The Grammar School, Manchester
June 21, 1883	Trans.	Wilson, David, jun., Carbeth, Killearn, by Glasgow
Nov. 19, 1855		Wilson, G. F., F.R.S., Heatherbank, Weybridge Heath
Feb. 21, 1895		Wilson, H., 146, High-street, Southampton
April 1, 1875		Wilson, James, M.A., Barrister-at-law, 2, Essex-court, Temple and 15, Highbury-grange, Highbury, N.
May 16, 1878		Wilson, James Henry, 6, Fenchurch-buildings, E.C.
May 16, 1895		Wilson, John, B.Sc., Battersea Polytechnic, S.W.
Dec. 3, 1891		Wilson, John Henry, A.I.C., 29, Radford-street, Coventry
Nov. 20, 1890		Wilson, J. Mitchell, M.D., Medical Officer of Health, Doncaster
Dec. 6, 1894		Wilson, R. H., Washing Stocks Farm, Bromsgrove
Dec. 7, 1871		Wilson, William John, 6, Malden-road, Watford
Dec. 17, 1885		Wilson, William M., Inland Revenue Laboratory, Burton-on-Trent
Feb. 5, 1874		Wiltshire, Thomas Pemberton, c/o New York Tartar Company, 9th-street and Gowanus Canal, Brooklyn, New York
Dec. 18, 1884		Wilton, Thomas, The Gas Light and Coke Co., Beckton, North Woolwich
Dec. 1, 1887		Winder, Bartlett W., Sunny Bank House, 43, Broomhall-place, Sheffield
Dec. 7, 1893		Winder, Edward Humphreys, Westminster School, S.W.
Feb. 15, 1894		Wingate, Hamilton M., B.Sc., c/o Messrs. J. Wingate and Co., 52, St. Enoch's-square, Glasgow
Dec. 5, 1895		Wingfield, T. R., Nelson-square, Bolton
Mar. 16, 1876		Winser, Percy James, Greendale, Bebington, near Birkenhead
Mar. 2, 1857		Winstone, Benjamin, M.D., 100, Shoe-lane, E.C., and 53, Russell-square, W.C.
Dec. 3, 1891		Winterion, A. W., The Express Steel Co., Port Talbot, South Wales
June 15, 1876	Trans.	Witt, Otto N., Prof., Ph.D., 21, Siegmundshof, Berlin, W.
May 7, 1896		Wolfenden, J. H., B.Sc., 13, Elm-street, Failsworth, Manchester
Dec. 5, 1867		Wood, Augustus A., 74, Cheapside, E.C.
April 4, 1889		Wood, Charles, 21, Queen's-road, Bradford, Yorks
Jan. 19, 1860	Trans.	Wood, Charles Henry, Bellevue, Rusham-road, Fgham

Date of Election.	
Dec. 4, 1890	Wood, Sidney, B.Sc., S. Kensington Museum, S.W.
Dec. 18, 1884	Wood, William H., B.A. (Oxon.), La Martinière, Calcutta
Dec. 7, 1871	Trans. Woodcock, Reginald C., The American and Continental Sanitation Company, 636 to 642, West 55th-street, New York
Feb. 18, 1892	Woods, Hugh, 11, Archway-road, Highgate, N.
April 19, 1888	Woodward, James, B.Sc., B.A., F.I.C., 144, Osborne-road, Forest Gate, E.
April 4, 1889	Woolf, Mortimer, 16, Greville-place, N.W.
Dec. 6, 1889	Woosnam, Richard W., 43, Dean-road, Willesden Park, N.W.
Dec. 18, 1884	Worrall, J. Hall, F.I.C., Howsley, Chapeltown, near Sheffield
Feb. 4, 1858	Trans. Worley, Philip J., Rodney Lodge, Clifton, Bristol
Dec. 5, 1895	Wright, H. E., Springhurst, Hartburn, Stockton-on-Tees
Feb. 21, 1878	Trans. Wright, Lewis Thompson, The Moun'ain Copper Co., Keswick, California, U.S.A.
June 7, 1894	Wright, Robert, 11, Eagle-parade, Buxton
Mar. 4, 1886	Trans. Wright, William T., 102, Derbyshire-lane, Sheffield
Feb. 4, 1864	Wrightson, John, Charford House, Salisbury
Feb. 19, 1891	Wyatt, Thomas M., Chemical Department, Royal Arsenal, Woolwich, S.E.
Dec. 2, 1880	Wyborn, John Middleton, 26, Widmore-road, Bromley, Kent
Nov. 20, 1884	Wyley, W. Fitzthomas, Wheatly-street, Coventry
May 7, 1885	Trans. Wynne, W. P., D.Sc., F.R.S., Royal College of Science, South Kensington, and 35, Parson's-green, Fulham, S.W.
June 4, 1874	Yates, Robert, 64, Park-street, Southwark
Dec. 16, 1886	Trans. Yoshida, H., Science College, Imperial University, Tokyo, Japan
Feb. 5, 1885	Young, Alfred C., 64, Tyrwhitt road, St. John's, S.E.
Mar. 4, 1886	Young, Brougham, 2A, Sigdon-road, Dalston-rise, N.E.
Mar. 15, 1877	Young, Frank W., High School, Dundee, and Woodmuir, West Newport, Fife, N.B.
Dec. 4, 1890	Trans. Young, George, Ph.D., Firth College, Sheffield
Feb. 21, 1895	Young, H. Stow, Santa Francisca Gold Mines, Leon, Nicaragua, Central America
June 21, 1877	Young, J. Rymer, 42, Sankey-street, Warrington
Feb. 5, 1874	Young, John, 164, Bath-street, Glasgow
June 16, 1887	Trans. Young, John William, B.Sc., B.A., Analyst's Office, Great Northern Railway Plant, Doncaster, and 25, Hall Gate, Doncaster
Feb. 16, 1882	Trans. Young, Sydney, D.Sc., F.R.S., University College, Bristol, and 10, Windsor-terrace, Clifton, Bristol
Dec. 16, 1894	Young, James, 4, Plumstead Common-road, Woolwich
Nov. 6, 1873	Young, W. C., Normanhurst, High-road, Romford, and Chemical Laboratory, Aldgate House, E.C.
April 4, 1878	Zingler, Maximilian, 19, Buckland-crescent, Belsize Park, N.W., and 16, Fenchurch-street, E.C.

FOREIGN MEMBERS.

NUMBER NOT TO EXCEED FORTY.

Date of Election.

May 18, 1876	Bayer, Adolph von, F.R.S., University of Munich
Feb. 1, 1883	Beilstein, Prof. F., Ph.D., W.O., 8th, No. 17, St. Petersburg.
Mar. 1 1860	Berthelot, M., F.R.S., Collège de France, Paris
Feb. 2, 1888	Boisbaudran, Lecoq de, 36, Rue Prony, Paris
Feb. 1, 1842	Bunsen, R. W., Ph.D., F.R.S., University of Heidelberg
June 19, 1862	*Cannizzaro, S., Senato di Roma
Feb. 1, 1883	Cleve, Prof. P. T., Ph.D., University, Upsala, Sweden
Feb. 1, 1883	Erlenmeyer, Prof. E., Ph.D., Aschaffenburg
June 16, 1892	Fischer, Emil, Ph.D., University of Berlin
Feb. 1, 1883	Fittig, Prof. R., Ph.D., University, Strassburg
May 18, 1876	Friedel, C., 9, rue Michelet, Paris
May 3, 1866	Gibbs, Prof. Wolcott, Cambridge, Massachusetts, U.S.
June 16, 1892	Graebe, Carl, Ph.D., University of Geneva
Feb. 2, 1888	Hoff, Prof. J. H. van't, Ph.D., Uhlandstrasse 2, Charlottenburg
Feb. 2, 1888	Ladenburg, Prof. A., Ph.D., Kaiser Wilhelmstrasse, 43, Breslau
Feb. 2, 1888	Landolt, Prof. H., Ph.D., Albrechtstrasse, 14, Berlin, N.W.
June 16, 1892	Lieben, Adolph, Ph.D., University of Vienna
Feb. 1, 1883	†Mendeléef, Prof. D., Ph.D., University, St. Petersburg
Feb. 1, 1883	Meyer, Prof. Victor, Ph.D., University of Heidelberg
Feb. 2, 1888	Nilson, Prof. L. F., Ph.D., Albano, Stockholm

* Faraday Lecturer, 1872.

† Faraday Lecturer, 1889.

Date of Election.

Mar. 1, 1860	Peligot, E., à la Monnaie, Paris
May 3, 1866	Rammelsberg, Prof. C. F., Berlin
June 16, 1892	Schiff, Hugo, Ph.D., University of Florence
June 16, 1892	Schloesing, Th., Ph.D., Institut Agronomique, Paris
May 18, 1876	Thomsen, Prof. Julius, Ph.D., University of Copenhagen
Feb. 2, 1888	Wislicenus, Prof. Johannes, Ph.D., University, Leipzig

 FARADAY LECTURERS.

- 1869. J. B. A. Dumas.
 - 1872. S. Cannizzaro.
 - 1875. A. W. von Hofmann.
 - 1879. A. Wurtz.
 - 1881. H. von Helmholtz.
 - 1889. D. Mendeléef.
 - 1895. Lord Rayleigh.
-

LONGSTAFF MEDALLISTS

- 1881. T. E. Thorpe, F.R.S.
- 1884. C. O'Sullivan, F.R.S.
- 1888. W. H. Perkin, F.R.S.
- 1891. F. R. Japp, F.R.S.
- 1894. H. T. Brown, F.R.S.
- 1897. W. Ramsay, F.R.S.

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ST. MARTIN'S LANE, W.C.

PROCEEDINGS
OF
THE CHEMICAL SOCIETY.

Vol. XIV. Nos. 187—201.
JANUARY—DECEMBER, 1898.

EDITED BY THE SECRETARIES.

LONDON:
GURNEY & JACKSON, 1, PATERNOSTERROW
1899.

RICHARD CLAY AND SONS, LIMITED,
LONDON AND BUNGAY.

DATES OF ISSUE OF THE MONTHLY NUMBERS OF THE
JOURNAL OF THE CHEMICAL SOCIETY TO FELLOWS.

January number was issued.....	18th January.
February „	15th February.
March „	15th March.
April „	15th April.
May „	16th May.
June „	16th June.
July „	13th July.
August „	4th August.
September „	2nd September.
October „	17th October.
November „	8th November.
December „	20th December.

LIST OF GRANTS MADE FROM THE RESEARCH FUND DURING THE YEAR.

£5 to John McCrae, Ph.D., for a research on the acid chlorides of glycollic and mandelic acids and their action on the sodium compounds of ethylic acetoacetate.

£5 to E. P. Perman, D.Sc., to continue his research on the vapour-pressure of aqueous ammonia.

£5 to A. Lapworth, D.Sc., for the further investigation of the sulphonic and other substitution derivatives of camphor.

£5 to John Wade, B.Sc., to continue his research on cyanides.

£5 to F. E. Matthews, Ph.D., to continue his research on the halogen addition compounds of benzene and its derivatives.

£5 to W. J. Elliott, M.A., to continue his research on the action of chloroform and alkaline hydroxides on amido-acids.

£10 to J. Wallace Walker, Ph.D., to continue his investigation of the derivatives of optically active mandelic acid.

£15 to W. J. Pope, for an investigation of the constitution of berberine and other compounds.

£15 to R. S. Morrell, M.A., and J. M. Crofts, B.Sc., to continue researches on the action of (a) ferric chloride on the ethereal salts of ketonic acids, (b) of hydrogen peroxide on carbohydrates in the presence of iron salts.

£25 to A. G. Perkin and J. J. Hummel, to continue their investigation of natural yellow colouring matters.

£10 to F. D. Chattaway, D.Sc., to continue his research on the composition and reactions of nitrogen iodide.

£20 to Prof. R. Meldola, F.R.S., to continue researches on poly-azo-compounds and anhydro-bases.

£10 to D. S. Jerdan, Ph.D., to examine the constitution of the orcinol and phloroglucinol derivatives obtained by the condensation of ethylic acetonedicarboxylate, and the behaviour of its mono- and di-substituted derivatives with sodium.

£10 to F. W. Dootson, M.A., to examine the action of halogens on ethylic acetonedicarboxylate.

£10 to John Harger, Ph.D., to prepare and examine compounds formed from methylsuccinic anhydride and secondary amines, and to work out a method of formation of di-alkyl succinic acids from mono-alkyl compounds.

£15 to W. A. Bone, D.Sc., and J. J. Sudborough, Ph.D., to prepare and examine the acid esters of (methyl) substituted succinic acids, and to attempt the resolution of 'racemic' substituted succinic acids into their optically active constituents.

£10 to J. J. Sudborough, Ph.D., to continue researches on diortho-substituted acids.

£15 to A. W. Crossley, Ph.D., and H. R. Le Sueur, B.Sc., to continue researches on the determination of the constitution of the fatty acids.

£15 to Prof. James Walker, D.Sc., to examine the configuration of camphoric acid and its isomerides with regard to the asymmetric carbon atoms by the electrolysis of allo-campholytic acids.

£10 to A. Lapworth, D.Sc., to examine the action of silver salts on halogen derivatives of camphor and allied compounds.

£10 to W. B. Davidson, Ph.D., to examine the stereoisomerism of diazo-compounds.

£15 to W. J. Pope, to continue researches on enantiomorphism.

LIST OF FELLOWS ELECTED DURING 1898.

Name.	Proposed.	Elected.
Abbott, Albert, B.A.	February 17th	April 21st.
Allhusen, Ernest Lionel, B.Sc.	December 16th, 1897.	February 17th.
Annable, Henry William Coupe.....	February 17th	April 21st.
Bailey, William Martin.....	January 20th	February 17th.
Baskerville, Charles, B.Sc., Ph.D.	February 3rd	April 21st.
Bell, Hugh Poynter, B.A.....	November 3rd	December 1st.
Berry, Reginald Arthur.....	" "	" "
Birkett, Walter.....	June 2nd	" "
Boardman, Thomas Henry, B.A.	November 3rd	" "
Bogert, Marston Taylor, A.B., Ph.B.....	" "	" "
Brearley, Harry.....	May 5th	June 16th.
Brierley, Joseph, B.Sc.	March 3rd.....	April 21st
Brittain, Charles Edward, B.Sc.....	December 2nd, 1897..	February 17th.
Brooke, Arthur, B.A.....	November 3rd	December 1st.
Brooks, Cecil Joslin	November 18th, 1897.	February 17th.
Brünnich, Johannes Christian.....	November 3rd	December 1st.
Bull, Benjamin S., M.A., B.Sc., Ph.D..	December 16th, 1897.	February 17th.
Burge, Charles Henry	November 18th, 1897.	" "
Caldecott, William Arthur, B.A.....	December 2nd, 1897..	February 17th.
Campion, Alfred.....	February 3rd.....	April 21st.
Cannon, Matthew J.....	November 18th, 1897.	February 17th.
Carroll, Charles Robert	November 17th	December 1st.
Castro, John Paul de.....	November 3rd.....	" "
Caven, Robert Martin, B.Sc.	February 3rd	April 21st.
Chapman, David Leonard, B.A.....	November 3rd.....	December 1st.
Cooper, A. J. Bullen.....	January 26th	February 17th.
Cooper, John, B.Sc.....	December 2nd, 1897..	" "
Cooper, William R., M.A., B.Sc.....	November 18th, 1897	" "
Cowburn, Arthur William.....	March 3rd.....	June 16th.
Cowling, Frederick	December 2nd, 1897..	February 17th.
Cox, Frederick Hudson.....	February 3rd	April 21st.
Crouch, William Samuel.....	November 3rd	December 1st.
Cunnington, Alfred V., B.A.....	" "	" "
Davidson, W. Brown, M.A., Ph.D.	" " "	" "
Davies, Charles W. Tisdale.....	May 19th	June 16th.
Dickson, Samuel.....	November 3rd	December 1st.
Dodd, Frederick Robertson.....	November 18th, 1897.	February 17th.
Don, John R., D.Sc. M.A.....	January 26th	" "
Dootson, Frederick W., M.A.....	" "	" "
Dowzard, Edwin.....	April 21st.....	June 16th.
Drake, Francis Alfred, B.Sc.....	November 3rd	December 1st.
Dudley, Charles Benjamin, Ph.D.....	March 3rd	April 21st.
Edwards, Wilbraham T. A.....	December 2nd, 1897..	February 17th.
Ferguson, James Edward.....	November 3rd	December 1st
Fleming, John Arnold.....	February 3rd	April 21st.
Foulerton, A. Grant Russell.....	April 21st.....	June 16th.
Gardner, Edward	June 16th	December 1st.

Name.	Proposed.	Elected.
Garside, Arthur L. H., B.Sc.....	March 3rd.....	April 21st.
Gidden, William Thomas.....	February 17th	" "
Gilderdale, Frederick.....	December 2nd, 1897..	February 17th.
Gilles, William Setten.....	" " " "	" "
Glaister, John, M.D.	January 20th.....	" "
Goldsmith, John Naish, B.Sc., Ph.D. ...	November 3rd	December 1st.
Guthrie, Alexander, B.Sc.	February 17th	April 21st.
Hadley, E. B.	November 3rd	December 1st.
Hamilton, Oswald.....	April 21st.....	June 16th.
Hartridge, Alfred, B.A.	June 2nd	December 1st.
Haworth, John	November 3rd	" "
Heaton, John.....	February 17th	April 21st.
Hemmy, A. Stanley, B.A., M.Sc.....	May 5th.....	June 16th.
Hendry, Alexander Garden.....	November 3rd	December 1st.
Hills, Thomas Herbert.....	December 16th, 1897	February 17th.
Hislop, Lawrence	March 3rd.....	April 21st.
Hislop, Robert Findlay	May 19th	June 16th.
Hodgson, Harry Pearson.....	February 3rd.....	April 21st.
Hohroyd, George W. F., B.A.	November 3rd	December 1st.
Homfray, David, B.Sc.	January 20th	February 17th.
Howe, Walter	November 3rd	December 1st.
Hyland, J. Shearson, M.A., Ph.D.	February 17th	April 21st.
Jarvis, George Arthur	April 21st	June 16th.
Jee, Edwin Charles, B.Sc.	February 3rd	April 21st.
Jessop, Samuel Morton	March 3rd.....	" "
Jones, Edward, B.Sc.	February 3rd	" "
Jones, Thomas Hill	November 3rd	December 1st.
Kay, Reginald Arundale	" "	" "
Lee, Harry Lancelot.....	April 21st.....	June 16th.
Lewins, William, B.Sc. ..	" "	" "
Lowry, Thomas Martin, B.Sc.	February 17th	April 21st.
Martin, George Herbert, B.A.	May 19th	June 16th.
Mascarenhas, John Charles... ..	November 3rd	December 1st.
Masson, George Henry, B.Sc.....	March 3rd.....	April 21st.
McEwen, Atholl Francis	January 20th	February 17th.
Meads, Charles James	May 19th	June 16th.
Miller, William Lash, Ph.D., B.A.	November 17th.....	December 1st.
Mills, William Hobson, B.A.	December 2nd, 1897	February 17th.
Mitchell, Albert Henry, B.Sc.	February 17th	April 21st.
Morgan, Gilbert Thomas	December 16th, 1897	February 17th.
Moss, William Edward	" "	" "
Nash, Leonard Myddleton	May 5th	June 16th.
Neilson, Alex. MacGillivray	April 21st.....	" "
Nightscales, Thomas Arthur	November 3rd	December 1st.
Pakes, Walter Charles Cross	March 3rd.....	April 21st
Parker, Alfred James	February 17th	" "
Pollard, William, B.A., Ph.D.	November 3rd	December 1st.
Poole, Herman	December 16th, 1897.	February 17th.
Pope, Thomas Henry	January 20th.....	" "

Name.	Proposed.	Elected.
Ratcliffe, Walter	February 3rd.	April 21st.
Ray, John Armstedt, jun., B.A.	November 3rd	December 1st.
Reid, James Brown	November 18th, 1897	February 17th.
Renwick, James Forster	December 2nd, 1897..	" "
Reynolds, William Colebrook.	" "	" "
Rich, Edmund Milton	November 3rd	December 1st.
Richards, William	December 16th, 1897.	February 17th.
Rigg, Gilbert	November 3rd	December 1st.
Rofe, Henry John, B.A.	" "	" "
Russell, Edward John, B.Sc.	May 5th	June 16th.
Sand, Henry J. S., Ph.D.	June 16th	December 1st.
Sayer, Harold Charles.	November 18th, 1897	February 17th.
Seligman, Richard	November 3rd	December 1st.
Senior, George, B.A.	" "	" "
Sheridan, Matthew Joseph.	May 19th	June 16th.
Smiles, Samuel, jun., B.Sc.	November 3rd	December 1st.
Smith, Benjamin Jordan	" "	" "
Smith, Francis Pitt.	March 3rd.	April 21st.
Smith, Thomas de, B.A.	" "	" "
Somerville, Henry, B.Sc.	February 3rd	" "
Spivey, William T. Newton, M.A.	March 3rd.	" "
St. John, Harry	February 3rd	" "
Stein, Sigmund.	May 5th	June 16th.
Steinhart, Oscar Julian, Ph.D.	March 17th.	" "
Stewart, Basil	November 3rd.	December 1st.
Tucker, Samuel Auchmuty, Ph.B.	March 17th.	June 16th.
Walker, Andrew Jamieson, B.A.	December 2nd, 1897..	February 17th.
Walker, Samuel, M.A., B.Sc.	February 17th	April 21st.
Waller, Henry French	April 21st.	June 16th.
Walton, Ambrose.	November 3rd.	December 1st.
Weissmüller, Ernest Charles	December 2nd, 1897..	February 17th.
Weston, Frank Edwin	May 5th	June 16th.
Whitaker, Edmund Thomas, B.Sc., M.B.	April 21st.	" "
Wild, William Ernest, B.Sc.	" "	" "
Wilder, Frederick Louis	November 17th	December 1st.
Williamson, John Alexander	March 3rd.	April 21st.
Williamson, William	May 5th	June 16th.
Witham, Ernest.	March 17th.	" "
Wood, Thomas Barlow, M.A.	March 3rd.	April 21st.
Woodhead, Samuel Allinson, B.Sc.	February 17th	" "
Woods, Charles William Tuthill.	June 2nd	December 1st.
Wrench, Charles Arthur	May 5th	June 16th.
Young, John Henry, B.Sc.	November 3rd	December 1st.

FELLOWS DECEASED.

Name.	Elected.	Died.
Ackland, Sir Thomas J.		
Dyke	April 7th, 1856	May 29th, 1898.
Burnett, W. R.	May 4th, 1893	October, 1898.
Conroy, Michael	February 15th, 1877	January 19, 1898.
Cook, E. Rider	November 5th, 1874	August 4th, 1898.
Foord, George	February 21st, 1853	May 15th, 1898.
Heywood, J. G.	December 1st, 1887	April, 1898.
Hiepe, W. L.	May 7th, 1891	February 13th, 1898.
Lowe, Charles	December 15th, 1856	November 1st, 1898.
Napier, James	June 21st, 1877	March 17th, 1898.
Newlands, J. A. R.	April 19th, 1860	July 29th, 1898.
Obach, Eugene	May 4th, 1886	December 27th, 1898.
Playfair, The Right Hon.		
Lord	February 23rd, 1841	May 29th, 1898.
Prentice, Manning	May 16th, 1864	November 20th, 1898.
Seely, H. W.	June 21st, 1888	August 4th, 1898.
Spencer, Samuel	February 6th, 1879	October 14th, 1898.
Smith, Matthew	December 5th, 1895	March, 1898.

TITLES OF PAPERS COMMUNICATED TO THE SOCIETY DURING 1898.

	Page in Pro- ceedings.	Page in Trans- actions.
<i>January 20th.</i>		
1. The preparation of pure iodine. By Bevan Lean, D.Sc., B.A., and W. H. Whatmough.....	5	148
2. Derivatives of bromotolylhydrazine. By J. T. Hewitt, M.A., D.Sc., and F. G. Pope.....	7	174
3. Researches on the terpenes. II. On the oxidation of fenchene. By John Addyman Gardner and George Bertram Cockburn.....	8	275
4. The action of alkalis on amides. By Julius B. Cohen, Ph.D., and Charles E. Brittain, B.Sc.....	10	157
5. The formation of monomethylaniline from dimethylaniline. By Julius B. Cohen, Ph.D., and Harry T. Calvert, B.Sc.....	10	163
6. Note on the aluminium-mercury couple. By Julius Cohen, Ph.D., and Harry T. Calvert, B.Sc.....	10	—
7. Action of chloroform and alkaline hydroxides on the nitrobenzoic acids. By Walter J. Elliott, M.A.....	10	145
<i>February 3rd.</i>		
8. The volumetric estimation of sodium. By H. J. H. Fenton, M.A.....	21	167
9. The atomic weight of boron. By F. P. Armitage.....	22	—
10. Rate of escape of ammonia from aqueous solution. By E. P. Perman, D.Sc.....	24	511
11. On the dissociation of potassium platinichloride in dilute solution: and the production of platinum mono- chloride. By E. Sonstadt.....	25	—
12. Effect of the mono-, di-, and tri-chloracetyl groups on the rotatory power of methylic and ethylic glycerates and tartrates. By Percy Frankland, F.R.S., and Thomas Stewart Patterson, Ph.D.....	28	181
13. The rotation of ethylic and methylic di-monochloracetyl- tartrates. By Percy Frankland, F.R.S., and Andrew Turnbull, Ph.D.....	29	203
<i>February 17th.</i>		
14. Observations on the influence of the silent discharge of electricity on atmospheric air. By W. A. Shenstone and W. T. Evans.....	39	246

	Page in Pro- ceedings.	Page in Trans- actions.
15. Some lecture experiments. By J. Tudor Cuudall, B.Sc.	40	—
16. Note on the preparation and properties of <i>o</i> -chlorobromobenzene. By J. J. Dobbie, M.A., D.Sc., and Fred Marsden, M.Sc., Ph.D.	41	254
17. The ultraviolet absorption spectra of some closed chain carbon compounds. By W. N. Hartley, F.R.S., and J. J. Dobbie, M.A., D.Sc.	41	598
18. Note on the absorption bands in the spectrum of benzene. By W. N. Hartley, F.R.S., and J. J. Dobbie, M.A., D.Sc.	42	695
19. A chemical examination of the constituents of Indian and American podophyllum. By Wyndham R. Dunstan, F.R.S., and T. A. Henry.	42	209
20. The volatile constituents of the wood of <i>Goupia tomentosa</i> . By Wyndham R. Dunstan, F.R.S., and T. A. Henry.	44	226
21. On oxycannabin from Indian hemp. By Wyndham R. Dunstan, F.R.S., and T. A. Henry.	44	—
22. On the condensation of formaldehyde with ethylic malonate, and on <i>cis</i> - and <i>trans</i> -tetramethylenedicarboxylic acids (1:3). By E. W. Haworth and W. H. Perkin, jun.	45	330
23. Formation of ethylic dihydroxydinicotinate from ethylic cyanacetate. By S. Ruhemann, Ph.D., M.A., and K. C. Browning, B.A.	47	280

March 3rd.

24. Preparation of anhydrous hydrogen cyanide and carbon monoxide. By John Wade, B.Sc., and Laurence C. Panting, M.B.	49	255
25. Production of some nitro- and amido-oxylutidines. By J. N. Collie, Ph.D., F.R.S., and Thomas Tickle.	50	229
26. Production of some nitro- and amido-oxylutidines. Part II. By Miss L. Hall and J. Norman Collie, Ph.D., F.R.S.	51	235
27. On benzene hexabromide. By F. E. Matthews, Ph.D.	52	243
28. Note on the action of bromine on benzene. By J. Norman Collie, Ph.D., F.R.S., and Colin C. Frye.	52	241
29. Note on manganic salts. By C. E. Rice, B.A.	53	258
30. Some chemical properties of concentrated solutions of certain salts. Part I. Potassium carbonate. By W. Colebrook Reynolds.	53	262
31. The colouring matters of the Indian dyestuff <i>Delphinium zaili</i> . By A. G. Perkin and J. A. Pilgrim.	55	267
32. Some metallic salts of natural yellow colouring matters. By A. G. Perkin and P. J. Wood.	56	—
33. The interaction of magnesium and solution of copper sulphate. By Edward Divers, M.D., F.R.S.	57	—

	Page in Pro- ceedings.	Page in Trans- actions.
<i>March 17th.</i>		
34. The reduction of bromic acid and the law of mass action. By Winifred Judson, B.Sc., and J. Wallace Walker, M.A., Ph.D.....	64	410
35. The action of ferric chloride on the ethereal salts of ketone acids. By R. S. Morrell, M.A., Ph.D., and J. M. Crofts, B.A., B.Sc.....	65	345
36. Note on the volatility of sulphur. By T. C. Porter, M.A.....	65	—
37. Cannabinol. By T. B. Wood, M.A.; W. T. N. Spivey, M.A., and T. H. Easterfield, M.A., Ph.D.....	66	—
38. Contributions to the chemistry of thorium. By Bohuslav Brauner, Ph.D.....	67	951
39. On the atomic weight of thorium. By Bohuslav Brauner, Ph.D.....	68	—
40. On the compound nature of cerium. By Bohuslav Brauner, Ph.D.....	69	—
41. On praseodymium and neodymium. By Bohuslav Brauner, Ph.D.....	70	—
42. Action of ammonia and substituted ammonias on acetylurethane. By George Young, Ph.D., and Ernest Clark.....	73	361
43. Formation of oxytriazoles from semicarbazides. By George Young, Ph.D., and Benjamin Mitchell Stockwell, B.Sc.....	73	368
44. Formation of $\alpha\alpha'$ -dihydroxypyridine. By S. Ruhemann, Ph.D., M.A.....	73	350
45. Position-isomerism and optical activity; the compara- tive rotatory powers of diethylic mono-benzoyl and mono-toluyltartrates. By Percy Frankland, F.R.S., and J. McCrae, Ph.D.....	74	307
46. The action of di-isocyanates upon amido-compounds. By H. Lloyd Snape, D.Sc., Ph.D.....	75	—
47. The action of alkyl iodides on silver malate and on silver lactate. By Thomas Purdie, F.R.S., and G. Druce Lander, B.Sc.....	75	287
48. On the optical rotations of methyl and ethyl tartrates. By J. W. Rodger and J. S. S. Brame.....	76	301
<i>April 21st.</i>		
49. The carbohydrates of barley straw. By C. F. Cross, E. J. Bevan, and Claude Smith	96	459
50. Isomeric bornylamines. By M. O. Forster, Ph.D.....	97	386
51. Some derivatives of benzophenone By Francis Edward Matthews, Ph.D.	97	426
52. Experiments on lauronic acid. By S. B. Schryver, Ph.D.	98	559
53. The drying of ammonia and of hydrogen chloride. By H. Brereton Baker, M.A.	99	422
54. Note on some of the properties of methylene di-iodide. By H. G. Madan, M.A.....	101	—

	Page in Pro- ceedings.	Page in Trans- actions.
55. The condensation of chloral hydrate with orcinol. By J. T. Hewitt, M.A., D.Sc., and F. Dixon, B.Sc.....	102	397
56. Note on hexamethylene and its derivatives. By Emily C. Fortey, B.Sc.....	103	932
57. The yellow colouring matter of the leaves of <i>Arctostaphylos uva ursi</i> . By A. G. Perkin.....	104	—
58. The yellow colouring matters of various adulterants of Sicilian sumach. Part V. By A. G. Perkin and P. J. Wood.....	104 106	374 490
59. The hydrolysis of starch by acids. By Harold Johnson	106	
60. Synthesis of <i>cis</i> - and <i>trans</i> -caronic acid." By W. H. Perkin, jun., and J. F. Thorpe.....	107	48*
61. Preparation of solid ammonium cyanate. By James Walker and John K. Wood.....	108	—
62. The chlorine derivatives of pyridine. Part I. By William J. Sell, M.A., F.I.C., and F. W. Dootson, M.A.	110	432
63. Simple experimental illustration of the law of multiples. By A. Wentworth Jones, M.A.	110	—
64. Lauronic acid. By R. W. Collinson and W. H. Perkin, jun.	111	—
65. The action of aluminium chloride on camphoric anhydride. By Frederic H. Lees and W. H. Perkin, jun.	111	—
66. On the action of bromoacetal on the sodium derivative of ethylic malonate. By W. H. Perkin, jun., and C. H. G. Sprankling.....	112	11*
67. The sulphonation of benzophenone and of diphenylmethane. By Arthur Lapworth, D.Sc.....	112	402
68. The separation of optical isomerides. By Frederic Stanley Kipping and William Jackson Pope.	113	—
<i>May 5th.</i>		
69. The action of hydrogen peroxide on carbohydrates in the presence of iron. By C. F. Cross, E. J. Bevan, and Claude Smith.....	115	463
70. Note on the oxidation of certain acids in presence of iron. By Henry J. Horstman Fenton, M.A.	119	—
71. Properties and relationships of dihydroxytartaric acid. Part II. Metallic Salts. By Henry J. Horstman Fenton, M.A.....	120	472
72. The affinity-constants of dihydroxymaleic, dihydroxyfumaric, dihydroxytartaric, and tartaric acids. By S. Skinner, M.A.....	121	483
73. Note on the enolic and ketonic forms of ethylic acetoacetate. By R. S. Morrell, M.A., Ph.D., and J. M. Crofts, B.A., B.Sc.....	121	—
74. The resolution of tetrahydropapaverine into its optically active components. By William Jackson Pope and Stanley John Peachey.....	122	893
75. Molecular weights of permanganates, perchlorates, and periodates in solution. By J. Murray Crofts, B.A., B.Sc.	124	593

	Page in Pro- ceedings.	Page in Trans- actions.
76. The action of chlorine on pyridine. By W. J. Sell, M.A., F.I.C., and F. W. Dootson, M.A.....	124	442
77. The oxidation of paranitrotoluenesulphonic acid to dinitrostilbenedisulphonic acid and to paranitrobenz- aldehydorthosulphonic acid. By R. Herz and W. H. Bentley.....	125	—
78. Determination of molecular weights: modification of Landsberger's boiling point method. By James Walker and John S. Lumsden.....	125	502
<i>May 19th.</i>		
79. The liquefaction of hydrogen and helium. By James Dewar, LL.D., F.R.S.	129	528
80. The action of formaldehyde on amines of the naphthalene series. By Gilbert T. Morgan, B.Sc.....	132	536
81. On the constitution of oleic acid and its derivatives. Part I. By Frank George Edmed, B.Sc..	133	627
82. Stereoisomeric derivatives of camphor. By T. M. Lowry, B.Sc.....	135	569
<i>June 2nd.</i>		
83. The boiling point and density of liquid hydrogen. By James Dewar, LL.D., F.R.S.....	146	534
84. The action of hydrogen bromide in presence of ether on carbohydrates and certain organic acids. By Henry J. Horstman Fenton, M.A., and Mildred Gostling, B.Sc.	147	554
85. Production of some chloropyridinecarboxylic acids. By J. N. Collie, Ph.D., F.R.S., and W. Lean....	148	588
<i>June 16th.</i>		
86. Preparation of a standard acid solution by direct absorp- tion of hydrogen chloride. By G. T. Moody.....	149	658
87. Researches on the terpenes. III. Halogen derivatives of fenchene and their reactions. By John Addyman Gardner, M.A., and George Bertram Cockburn, B.A.	150	704
88. Researches on the terpenes. IV. On the oxidation of fenchone. By John Addyman Gardner and George Bertram Cockburn.	151	708
89. Nitrocamphor and its derivatives. Part I. Isodynamic forms of nitrocamphor. By T. M. Lowry, B.Sc.....	151	986
90. Cannabinol. By T. B. Wood, M.A.; W. T. N. Spivey, M.A.; and T. H. Easterfield, M.A., Ph.D.....	153	—
91. An improved form of gas-analysis apparatus. By William A. Bone.....	154	—
92. Preliminary note on the action of light on acetylene. By William A. Bone and John Wilson.....	155	—

	Page in Pro- ceedings.	Page in Trans- actions.
93. Reversible zymohydrolysis. By Arthur Croft Hill, B.A.	156	634
94. The solubility of isomeric substances. By James Walker, Ph.D., D.Sc., and John K. Wood, B.Sc.	158	618
95. Note on nitration and substitution in nitro-compounds. By Arthur Lapworth, D.Sc., and Charles Mills.	159	—
96. Hydroxydibromocamphorsulphonic acid. A correction. By Arthur Lapworth, D.Sc., and F. Stanley Kipping, D.Sc., F.R.S.	159	—
97. Enantiomorphism. By F. Stanley Kipping, D.Sc., F.R.S., and William Jackson Pope.	160	606
98. Azobenzene derivatives of chrysin, euxanthone, gentisin, and morin. By A. G. Perkin.	161	659
99. Constituents of the Indian dyestuff "waras." By A. G. Perkin.	162	659
100. Note on the oxidation of charcoal by nitric acid. By G. Dixon, M.A., and T. H. Easterfield, M.A., Ph.D.	163	—
<i>Papers received during vacation and published in Transactions.</i>		
101. The vapour pressures, specific volumes, and critical constants of normal heptane. By Sydney Young, D.Sc., F.R.S.	165	675
102. Contributions to the chemistry of phenol derivatives. By Raphael Meldola and Frederick Henry Streatfeild.	165	681
103. Some iodoso-compounds. By John McCrae, Ph.D.	166	691
104. On myrticolorin, the yellow dye material of Eucalyptus leaves. By Henry G. Smith.	166	697
105. Chemical properties of concentrated solutions of certain salts. Part II. Double potassium succinates. By William Colebrook Reynolds.	167	701
106. Additive compounds of organic bases and ethereal salts of unsaturated acids. By S. Ruhemann and K. C. Browning.	167	723
107. Formation of ethereal salts of β -ketonic acids. By S. Ruhemann and K. C. Browning.	168	727
108. Disulphonic acids of toluene, of ortho- and para-toluidine, and of ortho- and para-chlorotoluene. By William Palmer Wynne, D.Sc., F.R.S., and James Bruce, B.Sc.	168	731
109. Chlorine derivatives of pyridine. Part II. Interaction of ammonia and pentachloropyridine. Constitution of glutazin. By W. T. Sell, M.A., and F. W. Dootson, M.A.	168	777
110. Mercury acetamide. By M. O. Forster, Ph.D., B.Sc.	169	783
111. Sulphocamphylic acid and isolauronic acid, with remarks on the constitution of camphor and of some of its derivatives. By W. H. Perkin, jun.	169	796
112. Researches on the terpenes. VIII. On carvenol: its reactions and products. By J. E. Marsh and A. Hartridge.	170	852

	Page in Pro- ceedings.	Page in Trans- actions.
113. Optically active alkyloxypropionic acids. By Thomas Purdie, F.R.S., and G. Druce Lander, B.Sc.....	170	862
114. The optical activity of gallotannic acid. By Otto Rosenheim, Ph.D., and Philip Schidrowitz, Ph.D....	171	878
115. The influences modifying the specific rotatory power of gallotannic acid. By Otto Rosenheim, Ph.D., and Philip Schidrowitz, Ph.D.....	172	885
116. The non-resolution of racemic tetrahydropapaverine by tartaric acid. By William Jackson Pope and Stanley John Peachey.....	172	902
<i>November 3rd.</i>		
117. Determination of the equivalent of cyanogen. By George Dean, B.A.....	174	—
118. The composition of American petroleum. By Sydney Young, D.Sc., F.R.S.....	175	905
119. The separation of normal and iso-heptane from American petroleum. By Francis E. Francis, B.Sc., Ph.D., and Sydney Young, D.Sc., F.R.S.....	176	920
120. The boiling points and specific gravities of mixtures of benzene and normal hexane. By D. Hamilton Jackson, M.A., Ph.D., and Sydney Young, D.Sc., F.R.S.....	176	922
121. The action of fuming nitric acid on the paraffins and other hydrocarbons. By Francis E. Francis, B.Sc., Ph.D., and Sydney Young, D.Sc., F.R.S.....	177	928
122. A composite sodium chlorate crystal in which the twin law is not followed. By William Jackson Pope.....	178	949
123. Stereoisomeric bromonitro- and chloronitro-camphors. By T. Martin Lowry, B.Sc.....	178	986
124. Camphoryloxime (camphonitrophenol). By T. Martin Lowry, B.Sc.....	179	986
125. The formation of ethereal salts of polycarboxylic acids. By S. Ruhemann and A. V. Cunningham.....	179	1006
126. Note on the action of light on platinum, gold, and silver chlorides. By E. Sonstadt.....	179	—
127. Methanetrisulphonic acid. By Ernest H. Bagnall, B.Sc.....	182	—
128. The nutrition of yeast. By Arthur L. Stern, D.Sc.....	182	—
129. The yellow colouring matters of <i>Rhus Cotinus</i> and <i>Rhus rhodanthema</i> . Part VI. By Arthur George Perkin.....	183	1016
130. Colouring matters of the New Zealand dyewood "puriri." By Arthur George Perkin.....	183	1019
131. Cannabinol. By T. B. Wood, M.A.; W. T. N. Spivey, M.A., and T. H. Easterfield, M.A., Ph.D.....	184	20*
132. Derivatives of hesperitin. By A. G. Perkin.....	185	1031
<i>November 17th.</i>		
133. Determination of the constitution of fatty acids. Part I. By Arthur W. Crossley and Henry R. Le Sueur.....	218	—

	Page in Pro- ceedings.	Page in Trans- actions.
134. The crystalline form of iodoform. By William Jackson Pope.....	219	46*
135. The characterisation of racemic compounds. By Frederic Stanley Kipping and William Jackson Pope.....	219	36*
136. The occurrence of orthohydroxyacetophenone in <i>Chione glabra</i> . By Wydham R. Dunstan and T. A. Henry.....	220	66*
137. Preparation of hyponitrite from nitrite through oxy-amidosulphonate. By E. Divers and T. Haga.....	220	77*
138. Absorption of nitric oxide in gas analysis. By E. Divers.....	221	82*
139. Interaction of nitric oxide with silver nitrate. By E. Divers.....	221	83*
140. Preparation of pure alkali nitrites. By E. Divers.....	222	85*
141. The reduction of an alkali nitrite by an alkali metal. By E. Divers.....	222	87*
142. Hyponitrites; their preparation by sodium or potassium and properties. By E. Divers.....	223	—
143. Paranitro-orthanisidine. By Raphael Meldola, F.R.S.	226	—
<i>December 1st.</i>		
144. The oxidation of polyhydric alcohols in presence of iron. By Henry J. Horstman Fenton, M.A., and Henry Jackson, B.A., B.Sc.....	240	1*
145. The occurrence of hyoscyamine in the <i>Hyoscyamus muticus</i> of India. By Wyndham R. Dunstan and Harold Brown.....	240	72*
146. The comparative colour of the vapour of iodine in gases at atmospheric pressure and in a vacuum. By James Dewar, LL.D., F.R.S.....	241	—
<i>December 15th.</i>		
147. The interaction of ethylic sodiomalonate and mesityl oxide. By Arthur W. Crossley.....	247	—
148. The interaction of ethylic malonate and acetylene tetrabromide in presence of sodium ethoxide. By Arthur W. Crossley.....	248	—
149. Derivatives of camphoric acid. Part III. By F. Stanley Kipping, D.Sc., F.R.S.....	249	—
150. Synthesis of $\alpha\beta\beta$ -trimethylglutaric acid. By W. H. Perkin, jun., and J. F. Thorpe.....	250	61*
151. Hydrolysis of methylic and ethylic γ -cyanoacetoacetates and their derivatives. Part I. By W. Trevor Lawrence.....	251	—

* Papers printed in the Transactions for 1899 are distinguished by an asterisk after the page number. Where no reference is given to the Transactions, the paper has appeared only in the "Proceedings."

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INDEX TO AUTHORS' NAMES.

- Armitage, F. P., 22.
 Bagnall, E. H., 182.
 Baker, H. B., 99.
 Bentley, W. H., 125.
 Bevan, E. J., 96, 115.
 Bone, W. A., 154, 155.
 Brame, J. S. S., 76.
 Brauner, Bohuslav, 67, 68, 69, 70.
 Brittain, C. E., 10.
 Brown, Harold, 240.
 Browning, K. C., 47, 167, 168.
 Bruce, J., 168.
 Calvert, H. T., 10.
 Clark, Ernest, 73.
 Cockburn, G. B., 8, 150, 151.
 Cohen, J. B., 10.
 Collie, J. Norman, 50, 51, 52, 148.
 Collinson, R. W., 111.
 Crofts, J. M., 65, 121, 124.
 Cross, C. F., 96, 115.
 Crossley, A. W., 218, 247, 248.
 Cundall, J. T., 40.
 Cunningham, A. V., 179.
 Dean, G., 174.
 Dewar, James, 129, 146, 241.
 Divers, Edward, 57, 220, 221, 222, 223.
 Dixon, F., 102.
 Dixon, G., 163.
 Dobbie, J. J., 41, 42.
 Dootson, F. W., 110, 124, 168.
 Dunstan, W. R., 42, 44, 220, 240.
 Easterfield, T. H., 66, 153, 163, 184.
 Edmed, F. G., 133.
 Elliott, W. J., 10.
 Evans, W. T., 39.
 Fenton, H. J. H., 21, 119, 120, 147, 240.
 Forster, M. O., 97, 169.
 Fortey, Emily C., 103.
 Francis, F. E., 176, 177.
 Frankland, Percy, 28, 29, 74.
 Frye, C. C., 52.
 Gardner, J. Addyman, 8, 150, 151.
 Gostling, Mildred, 147.
 Haga, T., 220.
 Hall, L., 51.
 Hartridge, A., 170.
 Hartley, W. N., 41, 42.
 Haworth, E. W., 45.
 Henry, T. A., 42, 44, 220.
 Herz, R., 125.
 Hewitt, J. T., 7, 102.
 Hill, A. Croft, 156.
 Jackson, D. H., 176.
 Jackson, H., 240.
 Johnson, Harold, 106.
 Jones, A. W., 110.
 Judson, Winifred, 64.
 Kipping, F. S., 113, 159, 160, 219, 249.
 Lander, G. Druce, 75, 170.
 Lapworth, Arthur, 112, 159.
 Lawrence, W. T., 251.
 Lean, Bevan, 5.
 Lean, W., 148.
 Lees, F. H., 111.
 Le Sueur, H. R., 218.
 Lowry, T. M., 135, 151, 178, 179.
 Lumsden, J. S., 125.
 Madan, H. G., 101.
 Marsden, Fred, 41.
 Marsh, J. E., 170.
 Matthews, F. E., 52, 97.
 McCrae, 74, 166.
 Meldola, R., 165, 226.
 Mills, Charles, 159.
 Moody, G. T., 149.
 Morgan, G. T., 132.
 Morrell, R. S., 65, 121.
 Panting, L. C., 50.
 Patterson, T. W., 28.
 Peachey, S. J., 122, 172.
 Perkin, A. G., 55, 56, 104, 161, 162, 183, 185.
 Perkin, W. H., jun., 45, 107, 111, 112, 169, 250.
 Perman, E. P., 24.
 Pilgrim, J. A., 55.
 Pope, F. G., 7.

- Pope, W. J., 113, 122, 160, 172, 178, 219.
 Porter, T. C., 65.
 Purdie, Thomas, 75, 170.
 Reynolds, W. C., 53, 167.
 Rice, C. E., 53.
 Rodger, J. W., 76.
 Rosenheim, O., 171, 172.
 Ruhemann, S., 47, 73, 167, 168, 179.
 Schidrowitz, P., 171, 172.
 Schryver, S. B., 98.
 Sell, W. J., 110, 124, 168.
 Shenstone, W. A., 39.
 Skinner, S., 121.
 Smith, Claude, 96, 115.
 Smith, H. G., 166.
 Snape, H. Lloyd, 75.
 Sonstadt, E., 25, 179.
 Spivey, W. T. N., 66, 153, 184.
 Sprankling, C. H. G., 112.
 Stern, A. L., 182.
 Stockwell, B. M., 73.
 Streatfeld, F. H., 165.
 Thorpe, J. F., 107, 250.
 Tickle, T., 50.
 Turnbull, A., 29.
 Wade, John, 49.
 Walker, James, 108, 125, 158.
 Walker, J. Wallace, 64.
 Whatmough, W. H., 5.
 Wilson, John, 155.
 Wood, J. K., 108, 158.
 Wood, P. J., 56, 104.
 Wood, T. B., 66, 153, 184.
 Wynne, W. P., 168.
 Young, George, 73.
 Young, Sydney, 165, 175, 176, 177.

INDEX TO DISCUSSIONS.

- Abel, Sir F., 205.
 Armstrong, H. E., 41, 118, 120, 131.
 Bloxam, A. G., 54.
 Bloxam, W. P., 54.
 Böttinger, H., 216.
 Brown, F. D., 244.
 Brown, H. T., 97, 158.
 Chapman, A. C., 148.
 Clowes, F., 53.
 Crookes, Sir W., 131, 209.
 Crossley, A. W., 134.
 Davis, W. A., 177.
 Dewar, James, 7, 24, 25, 45, 66, 72,
 100, 102, 174, 192.
 Dunstan, W. R., 133, 135, 225.
 Elworthy, H. M., 244.
 Fenton, H. J. H., 118, 121.
 Forster, M. O., 245.
 Foster, M., 213.
 Frankland, Sir E., 200.
 Friswell, R. J., 6.
 Gilbert, Sir J. H., 197.
 Gladstone, J. H., 207.
 Groves, C. E., 23, 177, 222, 241.
 Haldane, R. B., 215.
 Harcourt, A. Vernon, 102.
 Hehner, O., 22, 134.
 Huntly, G. N., 155, 225.
 Jones, L. M., 245.
 Lawson, T. A., 22.
 Ling, A. R., 51, 118, 158.
 Lister, Lord, 213.
 Matthews, F. E., 53.
 McLeod, H., 65, 155.
 Millard, E. J., 43.
 Morrell, R. S., 118.
 Newlands, J. A. R., 22.
 Odling, W., 202.
 Ostwald, W., 210.
 Reay, Lord, 211.
 Scott, A., 6, 23, 40.
 Shenstone, W. A., 100.
 Thorpe, T. E., 214, 244.
 Tilden, W. A., 52, 53, 54, 135.
 Travers, M., 245.
 Velej, V. H., 23.
 Voelcker, J. A., 96.
 Walker, J. Wallace, 121.
 Williamson, A. W., 206.
 Young, S., 177.

INDEX OF SUBJECTS.

- Absorption of gases by drying agents, 100.
 ——— spectra of closed chain carbon compounds, 41.
 ——— spectrum of benzene, 42.
 Acetalmalonic acid, preparation and properties of, 112.
 Acetylene, action of light on, 155.
 ——— tetrabromide, interaction of, and ethylic sodiomalonate, 243.
 Acetylurethane, action of ammonia and substituted ammonias on, 73.
 Acetylvitexin, preparation and properties of, 184.
 Acids, affinity-constants of certain, 121.
 ——— oxidation of, in presence of iron, 119.
 ——— polycarboxylic, formation of ethereal salts of, 179.
Ailantus glandulosa, colouring matter of, 105.
 Alcohols, polyhydric, oxidation of, in presence of iron, 240.
 Alkaloids, colour reactions of, 51.
 Alkyl iodides, action of, on silver malate and lactate, 75.
 Alkyloxypropionic acids, optically active, 170.
 Aluminium chloride, action of camphoric anhydride on, 111.
 Aluminium-mercury couple, 10.
 Amides, action of alkalis on, 10.
 Aminocampholactone, preparation and properties of, 99.
 Aminocannabinolactone, preparation and properties of, 67.
 Aminolutidone, preparation and properties of, 51.
 Aminopseudolutidostyrylcarboxylic acid, preparation and properties of, 51.
 Ammonia, drying of, 99.
 ——— rate of escape of, from aqueous solution, 24.
 ——— vapour pressure of solution of, 25.
 Ammonium cyanate, preparation of solid, 108.
 ——— morin, preparation of, 57.
 ——— thoroxalate, preparation and properties of, 68.
 Anniversary meeting, 89.
 ——— proposed notice of motion for supplemental charter at, 61.
 ——— action of Council thereon, 63.
Arctostaphylos uva ursi, yellow colouring matter of, 104.
 Asbarg, colouring matter of, 55.
 Atmospheric air, action of the silent discharge on, 39.
 Atomic weight of boron, 22.
 ——— nitrogen, 174.
 ——— Stas's determinations of, 175.
 Azobenzene derivatives of colouring matters, 161.
 Barley straw, carbohydrates of, 96.
 Benzene, absorption spectrum of, 42.
 ——— action of bromine on, 52.
 ——— and hexane, properties of mixture of, 176.
 ——— hexabromide, 52.
 Benzophenone, sulphonation of, 112.
 Benzophenone hexachloride, preparation and properties of, 98.
 ——— some derivatives of, 97.
 Borax, intumescence of, 23.
 ——— water of crystallisation of, 22.
 Bornylamines, isomeric, 97.
 Boron, atomic weight of, 22.
 Broach leaves, colouring matter of, 105.
 Bromacetal, action of, on sodium derivative of ethyl malonate, 112.
 Bromohexamethylene, preparation and properties of, 104.
 Bromic acid, reduction of, 64.
 π -Bromocamphanamide, preparation and properties of, 250.

- Bromonitrocamphors, stereoisomeric, 178.
o-Bromophenol, nitration of, 166.
 Bromotolyldiazine, derivatives of, 7.
 Bruca, colouring matter of, 105.
- Camphenol, identical with carvenol, 170.
 Campholactone, 111.
 Camphonitrophenol, constitution of so-called, 179.
 Camphor, constitution of, 169.
 ——— relation to cymene, 170.
 ——— stereoisomeric derivatives of, 135, 178.
 Camphoric acid, constitution of, 99.
 ——— derivatives of, Part III., 249.
 ——— yield of, from turpentine hydrochloride, 9.
 ——— anhydride, action of aluminium chloride on, 111.
 Camphoryloxime, 179.
 Cannabinol, 66, 153.
 ——— derivatives of, 184.
 Carbohydrates, action of hydrogen bromide on, in presence of ether, 147.
 ——— action of hydrogen peroxide on, 115.
 ——— of barley straw, 96.
 Carbon monoxide, preparation of, 49.
 Carbonic acid, synthesis of *cis*- and *trans*-, 107.
 Carvanol, preparation of, 170.
 Carvanone, preparation of, 170.
 Carvenol, reactions and products of, 170.
 Catalytic action of ferrous salts in oxidation of tartaric acid, 119.
 Cerium, compound nature of, 69.
 Certificates of candidates for election, 12, 79, 137, 227.
 Charcoal, oxidation of, by nitric acid, 163.
 Charter, proposed supplemental, correspondence relating to, 34, 61.
Chione glabra, odour of, 220.
 Chloracetyl groups, mono-, di- and tri-, influence on rotatory power of methylic and ethylic glycerates and tartrates, 28.
 Chloral hydrate, condensation of, with orcinol, 102.
o-Chlorobromobenzene, preparation and properties of, 41.
w- π -Chlorobromocamphoric acid, preparation and properties of, 250.
w- π -Chlorobromocamphoric anhydride, preparation and properties of, 250.
 Chlorobromofenchene, preparation and properties of, 150.
 Chlorofenchene, preparation and properties of, 150.
 Chlorohexamethylene, preparation and properties of, 103.
- Chlorolutidinecarboxylic acid, preparation and properties of, 148.
 Chloronitrocamphors, stereoisomeric, 178.
 Chloropyridinecarboxylic acids, production of, 148.
 α' -Chloropyridine- $\alpha\beta\gamma$ -tricarboxylic acid, preparation and properties of, 148.
o- and *p*-Chlorotoluenesulphonic acids, 168.
 Colour of pure iodine, 7.
 ——— reactions of alkaloids, 51.
 Colouring matter of, *Ailantus glandulosa*, 105; *Arctostaphylos uva ursi*, 104; Asbarg, 55; Broach leaves, 105; Bruca, 105; *Delphinium zaili*, 55; *Eucalyptus macrorhyncha*, 167; *Ficus carica*, 105; *Flemingia congesta*, 162; Gambuzzo, 105; *Pistacia lentiscus*, 104; *Pistacia terebinthus*, 105; *Podophyllum*, 43; Puriri, 183; *Rhus Coriaria*, 105; *Rhus Cotinus*, 183; *Rhus rhodanthema*, 183; Sicilian sumach adulterants, 104; Shinia leaves, 104; *Tamaris Gallica*, 105; *Tamaris Africana*, 105; Venetian sumach, 183; *Vitex littoralis*, 184.
 Concentrated solutions, chemical properties of, of potassium carbonate, 53.
 ——— potassium succinate, 167.
 Copper sulphate solution, action of magnesium on, 57.
 Cuprous iodide, decomposition of, 5.
 Cyanogen, equivalent of, 174.
- Delphinium zaili*, colouring matter of, 55.
 Dibromocamphorsulphonic acid, preparation and properties of, 160.
 Dichloropyridine hydrochloride, Keiser's, 124.
 Dichlorohexamethylene, preparation and properties of, 103.
 $\alpha\alpha$ -Diethyl- β -hydroxyglutaconic acid, properties of, 252.
 Diethylic mono-benzoyl and -toluoyltartrates, rotatory power of, 74.
 Diffusion, Graham's law of, lecture experiment on, 41.
 Dihydroxymaleic acid, formation of, from tartaric acid, explained, 119.
 Dihydroxytartaric acid, metallic salts of, 120.
 $\alpha\alpha'$ -Dihydroxypyridine, formation of, 73.
 Di-isocyanates, action of, on amido-compounds, 75.
 Dimethylaniline, conversion of, into monomethylaniline, 10.
 $\alpha\alpha$ -Dimethylglutaconic acid, preparation and properties of, 252.
 $\alpha\alpha$ -Dimethyl- β -hydroxyglutaconic acid, preparation and properties of, 251.

- Dinitrostilbenedisulphonic acid, from *p*-nitrotoluenesulphonic acid, 125.
- Diphenylenediphenylsemicarbazide, preparation and properties of, 75.
- Diphenylmethane, sulphonation products of, 112.
- 1 : 2 : 4-Diphenyltolylenediurea, preparation and properties of, 75.
- Disazochrysin, preparation and properties of, 161.
- Disazobenzene-euxanthone, preparation and properties of, 161.
- gentisin, preparation and properties of, 161.
- morin, preparation and properties of, 161.
- Elaidic acid, oxidation products of, 133.
- Election of Fellows, 39, 95, 149, 239.
- Election of Officers and Council, 38, 93.
- Electricity, action of silent discharge of, on air, 39.
- Enantiomorphism, 160.
- Ether and hydrogen bromide, action of, on certain carbohydrates, 147.
- Ethylic acetoacetate, enolic and ketonic forms of, 121.
- acetalmalonate, preparation and properties of, 112.
- γ -bromodiethylacetoacetate, properties of, 252.
- γ -bromomethylacetoacetate, properties of, 252.
- α -bromodimethylglutarate, preparation and properties of, 103.
- chlorolutidinemonocarboxylate, preparation and properties of, 148.
- α -cyano- $\beta\beta$ -dimethylglutarate, preparation of, 251.
- $\alpha\beta\beta$ -trimethylglutarate, preparation of, 251.
- γ -cyanodiethylacetoacetate, properties of, 252.
- methylethylacetoacetate, properties of, 252.
- dihydroxydinicotinate, formation of, from ethylic cyanacetate, 47.
- di-monochloracetyl tartrate, rotatory power of, 29.
- malonate, condensation of formaldehyde with, 45.
- interaction of acetylene tetrabromide with, 248.
- methylenemalonate, preparation and properties of, 45.
- sodiummalonate, interaction of, and mesityl oxide, 247.
- tetramethylenetetra-carboxylate, preparation and properties of, 46.
- Eucalyptus macrorrhyncha*, colouring matter of leaves of, 167.
- Fatty acids, determination of constitution of, 218.
- Feeding value of cereal straws, 96.
- Fenchene, halogen derivatives of, 150.
- preparation of, from fenchone, 6.
- products of oxidation of, 9.
- Fenchone, oxidation of, 151.
- Ferric chloride, action of, on ethylic salts of ketone acids, 65.
- Ficus carica*, colouring matter of, 105.
- Fisetin in the *Rhus* family, 183.
- Flemingia congesta*, colouring matter of, 162.
- Flemingin, preparation and properties of, 162.
- Foreign members, election of, 1.
- Formaldehyde, action of, on naphthylamines, 132.
- condensation of, with ethylic malonate, 45.
- Formalin, impurities of [commercial, 133.
- Galactose, oxidation by hydrogen peroxide in presence of iron, 118.
- Gallisin, 107.
- Gallotannic acid, optical activity of, 171, 172.
- Gambuzzo, colouring matter of, 105.
- Gas analysis, apparatus for, 154.
- absorption of nitric oxide in, 221.
- Gases, absorption of, by drying agents, 100.
- Gutmann's experiments on dried, 99.
- German Chemical Society, congratulations from, 218.
- Gluco-amylins, 107.
- Glucose, conversion into maltose by maltase, 157.
- oxidation by hydrogen peroxide in presence of iron, 116.
- Glutazin, constitution of, 168.
- Glycerates, effect of mono-, di-, and trichloracetyl groups on the rotatory power of, 28.
- Gold chloride, reduction of dilute solution by light, 179.
- Goupia tomentosa*, volatile constituents of, 44.
- Guaiacol, derivatives of, 166.
- Heat evolved in formation of ethereal salts of polycarboxylic acids, 179.
- Helium, liquefaction of, 130.
- Hemiracemic salts, 173.
- Heptane, constants of normal, 165.

- Heptane, separation of normal and iso-, from petroleum, 176.
- Hesperitin, derivatives of, 185.
- Hexahydrotrimesic acid, preparation and properties of, 46.
- Hexamethylene and its derivatives, 103.
- Hexane and benzene, properties of mixture of, 176.
- nitration of, 178.
- Homoflemingite, preparation and properties of, 162.
- Homovitexin, preparation and properties of, 184.
- Hydrocarbons present in American petroleum, 175.
- Hydrogen, boiling point and density of, 146.
- chemical relationships of, to paraffins, 131.
- properties of liquid, 130.
- Hydrogen, replacement of non-hydroxylic, by metals, 120.
- Hydrogen bromide, action on carbohydrates in presence of ether, 147.
- chloride, drying of, 99.
- ———— standard acid solution of, 149.
- Hydrogen cyanide, preparation of anhydrous, 49.
- peroxide, action of, on carbohydrates, 115.
- ———— presence of, in dilute solution of decomposing platinum chloride, 28.
- o*-Hydroxyacetophenone, occurrence of, in *Chione glabra*, 220.
- Hydroxybenzoic acids, solubility in water, 158.
- Hydroxycamphene, identical with carvenol, 170.
- Hydroxycampholactone, preparation and properties of, 99.
- Hydroxydibromocamphorsulphonic acid, a correction, 159.
- Hydroxylaminocampholactone, preparation and properties of, 99.
- Hyponitrite, preparation of, from nitrite of soda, 220.
- preparation and properties of, 223.
- Rây's basic, 224.
- Hyponitrous acid, volumetric estimation of, 225.
- Hyoscyamine, new source of, 240.
- Hyoscyamus muticus*, occurrence of hyoscyamine in, 240.
- Indian hemp, oxycannabin from, 44.
- Indicator for salicylic acid, 159.
- Indole derivatives, possible origin of, in plants, 220.
- Iodine, preparation of pure, 5.
- colour of vapour of, 241.
- crystalline form of, 6.
- transparent, in thin films, 241.
- Iodoform, crystalline form of, 219.
- p*-Iodo-orthacetanisidine, preparation and properties of, 226.
- Iodoso-compounds of phenylic substances, 166.
- Intumescence of fused borax, 23.
- Iron as a constituent of yeast nutriment, 183.
- Iron, influence of, on oxidation of carbohydrates, 115.
- ———— polyhydric alcohols, 240.
- Iron, influence of, on plant activity, 118.
- Isolauronic acid, constitution of, 169.
- Isomerides, solubility of, 158.
- Isorhamnetin, colouring matter of *Melphinium zaili*, 55.
- β*-Ketonic acids, ethereal salts of, 168.
- Ladenburg's method of characterising racemic compounds, 219.
- Lævulose, oxidation by hydrogen peroxide in presence of iron, 116.
- Landsberger's boiling point method, modification of, 125.
- Launonic acid, experiments on, 98.
- ———— properties of, 111.
- ———— constitution of, 170.
- ———— iso-, 169.
- Lecture experiments on conservation of mass and diffusion, 41.
- ———— illustrative of the law of multiples, 110.
- Light, action of, on platinum, gold, and silver chlorides, 179.
- Liquefaction of hydrogen and helium, 129.
- Lutidone derivatives, constitution of, 52.
- Magnesium, action of, on copper sulphate solution, 57.
- ———— morin, preparation of, 57.
- Maltose, reversible zymohydrolysis of glucose into, 157.
- Manganese tetrachloride, non-existence of, 53.
- Manganic chloride, decomposition of, reversible, 53.
- Mannitol, oxidation to mannose in presence of iron, 240.
- Mass action, law of, 64.
- Maturation of straw, affected by removal of flowers, 96.
- Mellitic acid, from the oxidation of charcoal, 163.
- Memorial to Council with reference to method of election of officers, 2.

- Mercury acetamide, action of, 169.
 ----- basic hyponitrites, Rây's, 225.
 Mesityl oxide, interaction of ethylic sodiomalonate with, 247.
 'Metafurfural,' Stenhouse's, 147.
 Methanetrisulphonic acid, preparation of, 182.
 Methylaniline, conversion of dimethylaniline into, 10.
 Methylene di-iodide, properties of, 100.
 $\alpha\alpha$ -Methylethyl- β -hydroxyglutaconic acid, 252.
 Methylic π -bromocamphanate, preparation and properties of, 250.
 ----- γ -cyanodimethylacetoacetate, preparation and properties of, 251.
 ----- dibromodimethylglutarate, preparation and properties of, 108.
 ----- di-monochloracetyltartrate, rotatory power of, 29.
 Molecular weights, determination of, 125.
 ----- in solution of permanganates, perchlorates, and periodates, 124.
 Multiples, experimental illustration of the law of, 110.
 Myrticorin, composition and properties of, 166.
 Naphthacridine, salts of, preparation and properties of, 132.
 α and β -Naphthylamine, action of formaldehyde on, 132.
 Neobornylamine, preparation and properties of, 97.
 Neodymium, 70.
 Newlands, the late Mr. J. A. R., 174.
 Nitration of hexane, 178.
 ----- of paraffins, 177.
 Nitric oxide, absorption of, in gas analysis, 221.
 ----- interaction of, with silver nitrate, 221.
 Nitric peroxide, formation of, under silent discharge, 40.
 Nitrites, preparation of pure alkali, 222.
 ----- reduction of alkali, by an alkali metal, 222.
p-Nitrobenzaldehydorthosulphonic acid, 125.
 Nitrobenzoic acids, action of chloroform and alkaline hydroxides on, 10.
 Nitrocampcholactone, preparation and properties of, 99.
 Nitrocamphor, isodynamic forms of, 151.
 Nitrocannabinolactonic acid, preparation of, 185.
 Nitro-compounds, nitration and substitution in, 159.
 Nitrogen, atomic weight of, 174.
 5-Nitro-2-iodotoluene, some derivative of, 166.
 Nitrolutidone, preparation and properties of, 51.
p-Nitro-orthanisidine, acetyl derivatives of, 226.
 Nitropseudolutidostyryl, preparation and properties of, 50.
 Nitrotoluenesulphonic acid, oxidation of, 125.
 Nitrosocampcholactone, preparation and properties of, 99.
 Nitrosocamphor, Cazeneuve's, 152.
 Octacetylmaltose in the test for maltose, 158.
 Olefines in petroleum, 177.
 Oleic acid, constitution of, 133.
 ----- oxidation products of, 133.
 Optical activity of alkyloxypropionic acids, 171.
 ----- chloracetyl-glycerates and tartrates, 28, 29.
 ----- gallotannic acid, 171.
 Optical isomerides, separation of, 113.
 Oxyamidodisulphonate, in preparation of hyponitrite of soda, 221.
 Oxycannabin from Indian hemp, 44.
 Oxylutidines, production of nitro- and amido-, 50.
 Oxytriazoles, formation of, from semicarbazides, 73.
 Ozone, preparation of, from air or oxygen, 40.
 Papaverine, Goldschmiedt's formula for, 122.
 ----- tetrahydro-, optical isomerides of, 122.
 Paraffins, influence of molecular weight on constants of, 165.
 ----- nitration of, 177.
 Past Presidents, banquet to, 189.
 Pentachloropyridine, interaction of ammonia and, 168.
 Perchlorates, molecular weights in solution of, 124.
 Periodates, molecular weights of, in solution, 124.
 Periodic law, elements of eighth series of, 72.
 Permanganates, molecular weights of, in solution, 124.
 Petroleum, composition of American, 175.
 Phenol, nitration of bromine derivatives of, 165.
 Phosphorus, methylene di-iodide as a solvent for, 102.

- Phosphorus pentoxide as a drying agent for gases, 99.
- preparation of pure, 100.
- Picropodophyllin, preparation and properties of, 43.
- Pinene hydrochloride, oxidation products of, 9.
- Piperidine, additive compounds of, 167.
- Pistacia lentiscus*, colouring matter of, 104.
- Pistacia terebinthus*, colouring matter of galls of, 105.
- Platinum monochloride, preparation and properties of, 26.
- Playfair, the late Lord, 145.
- Podophyllic acid, preparation and properties of, 42.
- Podophyllotoxin, preparation and properties of, 42.
- Podophyllum*, colouring matter and resin of, 43.
- the constituents of Indian and American, 42.
- Polymerisation of ethylic methylenemalonate, 45.
- Position-isomerism and optical activity, 74.
- Potassium carbonate, chemical properties of concentrated solution of, 53.
- morin, preparation and properties of, 56.
- nitrite, preparation of pure, 222.
- platinichloride, dissociation of, in dilute solution, 25.
- quercetin, preparation and properties of, 56.
- succinate, chemical properties of concentrated solution of, 167.
- Praseodymium, 70.
- tetroxide, preparation and properties of, 71.
- Pseudonitrocamphor, 152.
- Puriri, colouring matters of, 183.
- Pyridine, action of chlorine on, 124.
- chlorine derivatives of, 110, 168.
- Racemic compounds, characterisation of, 219.
- Refractive index of methylene di-iodide, 101.
- Resolution of alkyloxypropionic acids with morphine and cinchonidine, 171.
- Rhus Coriaria*, colouring matter of stalks of, 105.
- Rhus Cotinus* and *Rhus rhodanthema*, yellow colouring matters of, 183.
- Rotatory power, effect of chloracetyl groups on, 28.
- Rotatory power of methylic and ethylic glycerates and tartrates, 29.
- of methylic and ethylic tartrates, 76.
- Russian Chemical Society, congratulations from, 217.
- Salicylic acid, indicator for, 159.
- Semicarbazides, formation of oxytriazoles from, 73.
- Shinia leaves, colouring matter of, 104.
- Sicilian sumach adulterants, colouring matter of, 104.
- Silver chloride, action of light on, when exposed under water, 180.
- action of light on dry, 180.
- Silver hyponitrite, preparation and properties of, 224.
- nitrate, interaction of, with nitric oxide, 221.
- nitrito-hyponitrite, non-existence of, 224.
- Sodium, volumetric estimation of, 21.
- Sodium chlorate crystal, an anomalous, 178.
- Sodium ethoxide, in condensation of polycarboxylic acids, 179.
- hyponitrite, preparation and properties of, 224.
- morin, preparation and properties of, 57.
- nitrite, preparation of pure, 222.
- quercetin, preparation and properties of, 56.
- Solubility of podophyllum resin, 43, 44.
- Standard solution of hydrochloric acid, preparation of, 149.
- Starch, hydrolysis of, by acids, 106.
- Statistics of the Society, 91.
- Stereoisomerism of substituted nitrocamphors, 178.
- Straws, feeding value of cereal, 96.
- Succinates, double potassium, properties of, 167.
- Sulphocamphylic acid, constitution of, 169.
- Sulphur, an essential constituent of yeast food, 182.
- vapour tension of, 66.
- volatility of, 65.
- Sulphuric acid, action of, on potassium cyanide, 50.
- Tamaris Gallica*, and *T. Africana*, colouring matter of, 105.
- Tartrates, effect of mono-, di-, and trichloracetyl groups on rotatory power of, 28.
- rotatory power of benzoyl and toluoyl, 74.
- rotatory power of methyl and ethyl, 76.

- Terpenes, researches on, 170.
 Tetrahydropapaverine, racemic, not resolved by tartaric acid, 172.
 ————— resolution of, into its optically active components, 122.
d. ————— preparation and properties of, 123.
l. ————— preparation and properties of, 123.
d. and *l*-Tetrahydropapaverine dextro-bromocamphorsulphonate, preparation and properties of, 123.
 Thorium, atomic weight of, 68.
 ————— oxalate, solubility in ammonium oxalate solution, 67.
 Toluenedisulphonic acids, 168.
o- and *p*-Toluidinedisulphonic acids, 168.
 Tolylenediphenylsemicarbazide, preparation and properties of, 75.
 1 : 2 : 4-Tolylene-diurea, preparation and properties of, 75.
 Triethylic anhydro-oxalaconitate, formation of, 167.
 $\alpha\beta\beta$ -Trimethylglutaric acid, synthesis of, 250.
 $\alpha\beta\beta$ -Trimethylglutarimide, preparation of, 251.
 Turpentine hydrochloride, oxidation products of, 9.
 Twin law, a composite crystal which does not follow the, 178.
 Vapour density of ammonium chloride, 100.
 Vapour pressure due to water of hydrated salts, 24.
 ————— of ammonia solution, 25.
 Venetian sumach, myricetin the colouring matter of, 183.
 Vitexin, colouring matter of *Vitex littoralis*, 184.
 Volatility of sulphur, experiments on, 65, 66.
 Waras, constituents of, 162.
 Yeast, nutrition of, 182.
 Zymohydrolysis, reversible, 156.

ERRATA.

Page.	Line.
8	26 for "I" read "II."
41	1 ,, "filled" read "fitted."
41	13 omit "which is then."
58	31 for "cuprous" read "cupric."
96	6 ,, "Claud" read "Clande."
99	32 ,, "cylic" read "cyclic."
149	13 omit "Ph.D."
163	2 for "Dickson" read "Dixon."
175	26 ,, "for" read "from."
239	12 ,, "Szarasy" read "Szarvasy."

PROCEEDINGS
OF THE
CHEMICAL SOCIETY.
EDITED BY THE SECRETARIES.

No. 187.

Session 1897-8.

January 20th, 1898. Professor Dewar, F.R.S., President, in the Chair.

Mr. Oscar Guttman was formally admitted a Fellow of the Society.

Certificates were read for the first time in favour of Messrs. W. M. Bailey, 13, Green Lane Road, New Evington, Leicester; A. J. B. Cooper, Grimston Lawn, Ealing, W.; John R. Don, D.Sc., M.A., Waitaki, Oamaru, N.Z.; F. W. Dootson, M.A., Bryn, Glisson Road, Cambridge; John Glaister, M.D., 4, Grafton Place, Grafton Square, Glasgow; David Homfray, B.Sc., 6, Dartmouth Row, Greenwich, S.E.; A. F. McEwen, 43, Gilmore Road, Lewisham, S.E.; T. H. Pope, South Street, Ponders End.

ELECTION OF FOREIGN MEMBERS.

A ballot for the election of Foreign Members was held, and the following were subsequently declared duly elected:—Professors S. Arrhenius, Th. Curtius, A. P. N. Franchimont, W. Körner, W. Markownikoff, N. A. Menshutkin, H. Moissan, W. Ostwald, F. M. Raoult, I. Remsen, W. Spring, L. J. Troost, P. Waage, J. D. van der Waals.

ANNOUNCEMENT BY THE COUNCIL.

The PRESIDENT said that he was authorised by the Council to make the following statement to the Society:—

“The Council of The Chemical Society have received the following Memorial and enclosures.

Owing to the action of the Bye-laws Committee, which was appointed some time ago, the Council is in a position to give an immediate answer to the Memorialists.

The question of the power of the Society to alter the mode of election of the Officers and Council having arisen, the Bye-laws Committee requested the solicitors of the Society, Messrs. Wilson, Bristows, and Carpmael, to submit the following case for legal opinion.

Case for the Opinion of Counsel.

The opinion of Counsel is desired by the President and Council of The Chemical Society under the following circumstances:—

A memorial is being extensively signed by the Fellows of The Chemical Society, addressed to the President and Council of such Society asking that the Bye-laws may be altered so as to allow the votes at the General Annual Meetings to be given by proxy. A printed copy of such Memorial is sent herewith.

The attention of Counsel is directed to page 8 of the printed copy of the Charter of The Chemical Society, which is sent herewith, and also to pages 16 and 17 of such document. On the latter of which pages will be found the present Bye-laws on the subject.

Counsel is desired to advise the President and Council of The Chemical Society whether, under their charter, they have power to alter the Bye-laws so as to provide for the votes at General Meetings being given by proxy.

The following is the opinion of Counsel.

Copy of Opinion of Mr. COZENS-HARDY, Q.C.

I am of opinion that the Charter (p. 8) prohibits voting by proxy and that any Bye-law framed for the purpose of allowing voting by proxy would be repugnant to the Charter (p. 9) and invalid.

HERBERT H. COZENS-HARDY.

7 New Square, Lincoln's Inn,
December 6, 1897.

This opinion of Mr. Cozens-Hardy, Q.C., makes it clear that the Council of the Society have not the power to propose such an alteration of Bye-law V. as the Memorialists request.

The suggestion made by Messrs. Harden and Hartog in the letter addressed to the Secretaries along with the Memorial, that "*it would probably be necessary to obtain a Supplementary Charter allowing members not actually present at meetings to vote by means of balloting papers,*" opens up questions outside the terms of the Memorial, which will necessitate further legal advice. The whole subject is receiving the most careful consideration of the Council."

Of the following papers those marked * were read :—

- *1. "The preparation of pure iodine." By Bevan Lean, D.Sc., B.A., and W. H. Whatmough.

Stas, in his *Nouvelles Recherches sur les Lois des Proportions Chimiques*, states that he was only able to find two methods of preparing iodine free from chlorine and bromine. One consisted in precipitating by water iodine dissolved in potassium iodide, the other depended on the decompositions of iodide of nitrogen by heat. Perhaps the main difficulty attached to these methods was the desiccation of the iodine and the removal of hydriodic acid. Neither in his published memoirs nor in his laboratory note-books has Stas stated how he assured himself that his "iodine" was free from other halogens.

A few months ago the authors observed incidentally that no iodine is set free when cuprous iodide is heated, even at its fusion point, in a current of carbonic anhydride, although it is readily evolved when cuprous iodide is heated in air, oxygen, nitric oxide or nitrogen peroxide. The action is represented by the equation $\text{Cu}_2\text{I}_2 + \text{O}_2 = 2\text{CuO} + \text{I}_2$. No iodine is evolved when cuprous iodide is heated in a vacuum.

The authors have examined the usual methods of preparing cuprous iodide. When a solution of cupric sulphate and a soluble chloride, bromide, or iodide, is saturated with sulphurous acid, cuprous iodide, bromide and chloride may all be precipitated; but there is so great a difference in their degree of solubility that, by securing a proper dilution, it is probable that cuprous iodide can be prepared free from cuprous bromide or chloride. A mixture of cupric sulphate and ferrous sulphate is still less liable to precipitate cuprous bromide and chloride along with cuprous iodide than cupric sulphate saturated with sulphurous acid. The authors have found that cuprous iodide can also be prepared by sprinkling iodoform in small quantities at a time upon a hot surface of copper. On account of the difference in the properties of chloroform, bromoform and iodoform, it is probable that, by this method also, cuprous iodide can be prepared entirely free from bromide or chloride. If, moreover, the cuprous iodide is fused in a current of carbonic anhydride or in vacuo, it can be freed completely from moisture.

Iodine is most conveniently prepared from cuprous iodide by heating it in a stream of dry air at $220-240^\circ$ and condensing the vapours upon a cold surface. Although the greater portion of the iodine in a given quantity of cuprous iodide is quickly expelled, it is not easy to expel the whole; after heating 1.7101 grams at 400° for 18 hours, 0.15 per cent. of the iodide was still undecomposed—otherwise the relation $\text{Cu}_2\text{I}_2:2\text{CuO}$ could have been utilised for the exact measurement of the atomic weights of copper, iodine, and oxygen. The authors are

making further experiments upon this point. The action of air upon cuprous iodide is not dependent upon the presence of moisture. This is established by sealing cuprous iodide in glass tubes in the presence of phosphoric anhydride.

Iodine liberated as described from cuprous iodide at 240° leaves absolutely no residue when volatilised at 75° . If examined spectroscopically, no evidence of the presence of copper can be found. The melting point (uncorrected) is $112.5-114^{\circ}$.

Whether such iodine is as pure as that prepared by Stas or not, it appears desirable to redetermine the atomic weight of the element prepared by this method.

DISCUSSION.

Dr. SCOTT remarked that Stas depended on distillation two or three times with anhydrous baryta, and not on calcium nitrate, for the complete removal of water from his iodine. This reagent had also the great advantage of removing any traces of hydriodic acid, the calcium nitrate being only used for the removal of the greater part of the water. Although Stas does not give his methods of testing his iodine for traces of chlorine and bromine, his concluding remarks in that section of his paper evidently show that he had no doubts as to its purity. The marvellous agreement of his results with those of Marignac, who found 100 grams of silver gave 217.5334 of silver iodide, whilst Stas found in his complete synthesis 217.5335, will probably convince most chemists that both were dealing with the same chemical substance.

Mr. R. J. FRISWELL asked if the author had observed the crystalline form and appearance of the sublimed iodine. He had himself a very interesting experience in this matter with iodine recovered from methyl iodide by Nicholson's method of recovering the iodine, used in methylating rosaniline by mixing the sulphuric acid and sodium bichromate with the waste iodine liquor, the precipitated iodine being washed, pressed and fused under sulphuric acid.

For many years he (Mr. Friswell) had noticed that at times the sulphuric acid used for the fusion contained a mass of minute, violet-brown, glistening plates, but every attempt to collect them failed, the least dilution of the acid causing them instantly to disappear. After some time, however, nearly a pound of a paste or magma of these crystals was obtained in the following way. The acid was allowed to dilute itself by the absorption of water from the air and then run off from the crystals; the magma of crystals was thrown on to a vacuum filter and washed with sulphuric acid of continually increasing dilution and at length with water; the paste was then squeezed and, while moist, sublimed in a beaker covered with a loose glass plate at a temperature of $35-40^{\circ}$.

At first, the ordinary violet plates of iodine appeared, with a little water, but these soon vanished and intensely black, adamantine, solid rhombic (?) crystals appeared. A brownish earthy residue was left. The crystals were of considerable size, a cubic mm. or so in content. He thought that since these had been obtained from iodine continually in use for many years, during which time some tons of iodine had passed through the operation, they might be the companion element which has been suspected. Prof. Ramsay was asked to examine the crystals and the paste from which they had been sublimed, but found that the adamantine crystals gave no residue on sublimation and showed 99.84 per cent. iodine, the deficit being probably due to a slight accidental loss. On sublimation in a vacuum, both the plate-like crystals which first sublimed and iodine purified in the usual way left slight yellowish residues, but these adamantine crystals left none. They were, therefore, pure iodine. He wished to know whether the author's substance resembled these crystals in any way.

The PRESIDENT mentioned, as indicating the general trustworthiness of Stas's observations, that he had recently confirmed Stas's remarkable statement, that, when pure, solid iodine is opaque to light. He inquired whether Dr. Lean had made any experiments with palladious iodide.

Dr. LEAN, in reply, said that he had not noticed anything anomalous in the crystallisation of the iodine. He had observed, however, that his iodine had a black and not a deep violet colour, and that it emitted no visible vapour at the ordinary temperature. Stas had made a similar observation.

The reason he had not made most of his experiments with palladious iodide was that it was so much more expensive than cuprous iodide. He had, however, made a few experiments which showed that iodine was very readily liberated when palladious iodide was heated in air.

***2. "Derivatives of bromtolylhydrazine." By J. T. Hewitt, M.A., D.Sc., and F. G. Pope.**

This is a continuation of the work of one of the authors on ortho-substituted phenylhydrazines. The hydrazine was prepared from the amido-compound by the method of Victor Meyer and Lecco (*Ber.*, 1883, 16, 2976) an alteration being made by pouring the solution of the diazonium salt into the stannous chloride solution. The free hydrazine and the following salts and derivatives are described.

Bromtolylhydrazine, $C_6H_3BrMe(N_2H_3)$, 1:3:6, colourless needles, m. p. 91° , *hydrochloride*, $C_7H_6Br \cdot N_2H_3 \cdot HCl$, colourless needles, m. p. 190° , *nitrate*, $C_7H_6Br \cdot N_2H_3 \cdot HNO_3$, colourless plates, m. p. 154° ,

sulphate, $(C_7H_6Br \cdot N_2H_3)_2 \cdot H_2SO_4$, colourless needles, m. p. 201° , *oxalate*, $(C_7H_6Br \cdot N_2H_3)_2 \cdot H_2C_2O_4$, small colourless prisms, m. p. about 150° . *Acetylbromtolylhydrazine*, $C_7H_6Br \cdot NH \cdot NH \cdot COMe$, colourless prisms, m. p. 124° . *Bromtolylsemicarbazide*, $C_7H_6Br \cdot NH \cdot NH \cdot CO \cdot NH_2$, small colourless crystals, m. p. 163° . *Bromtolylallylthiosemicarbazide*, $C_7H_6Br \cdot NH \cdot NH \cdot CS \cdot NH \cdot C_3H_5$, colourless prisms, m. p. 136.5° . *Bromtolylphenylthiosemicarbazide*, $C_7H_6Br \cdot NH \cdot NH \cdot CS \cdot NH \cdot C_6H_5$, small prisms often grouped in radiating clusters, m. p. 142° ; the freshly prepared substance usually has a somewhat lower melting point, and this may possibly be a case of isomerism similar to that observed by Marckwald with diphenylthiosemicarbazide (*Ber.*, 1892, 25, 3098). *Furfuraldehydebromtolylhydrazone*, $C_4H_3O \cdot CH : N_2H \cdot C_7H_6Br$, needles, m. p. 87° . *Benzaldehydebromtolylhydrazone*, $C_6H_5 \cdot CH : N_2H \cdot C_7H_6Br$, rhomboidal plates, m. p. 84° . *Salicylaldehydebromtolylhydrazone*, $C_6H_4(OH) \cdot CH : N_2H \cdot C_7H_6Br$, needles, m. p. 109° , and the following bromtolyl hydrazones of:—*pyruvic acid*, $C_7H_6Br \cdot NH \cdot N : CMeCO_2H$, yellow crystals, m. p. 175° : *ethyl pyruvate*, $C_7H_6Br \cdot NH \cdot N : CMeCO_2Et$, tufts of needles, m. p. $84-85^\circ$: *potassium pyruvate* (with 3 mols. of water), $C_7H_6Br \cdot NH \cdot N : CMeCO_2K, 3H_2O$: *ammonium pyruvate*, $C_7H_6Br \cdot NH \cdot N : CMeCO_2NH_4$, (both these salts are soluble in hot water, sparingly, however, in cold water): *lead pyruvate*, $[C_7H_6Br \cdot NH \cdot N : CMeCO_2]_2Pb$, a pale yellow precipitate.

The effect of heat on the potassium and lead salts is to furnish potassium or lead bromide as well as basic and acidic or phenolic decomposition products. The reactions are being further examined.

***3. "Researches on the terpenes. I. On the oxidation of fenchene."**
By John Addyman Gardner and George Bertram Cockburn.

The authors give an account of their method of producing fenchene from fenchone, the oxidation products of fenchene, and pinene hydrochloride.

Fenchone, b. p. $191-192^\circ$, m. p. 6° , specific rotatory power $[\alpha] = +61.58'$, was reduced to fenchyl alcohol by a modification of Wallach's method, using amyl alcohol and sodium instead of ethyl alcohol and sodium. It was obtained in hard, white crystals, m. p. 45° , specific rotatory power $[\alpha] = -13.38'$.

The fenchyl alcohol was converted into fenchyl chloride by the action of phosphorus pentachloride, and this into fenchene by saponification with aniline. The bulk of the fenchene thus obtained distilled for the most part between 150° and 156° , several degrees lower than that described by Wallach, which boiled between 158° and 160° . A fraction $152-154^\circ$ was shown by combustion to have the formula $C_{10}H_{16}$. Its specific gravity was 0.8667 at 18° and specific rotatory power $[\alpha] =$

—6° 46' (not in solution). The specific gravity of Wallach's hydrocarbon was 0.864 at 20° and it was optically inactive.

As a bye-product in the action of fenchyl chloride on aniline, the authors obtained a black oil, not volatile in steam. This substance did not solidify on standing, but on distillation under reduced pressure came over for the most part at 171—173° at 13 mm. pressure. It was a pale yellow, thick, viscous oil which turned black on exposure to air. Analysis showed it to have the composition $C_{10}H_{17}NHC_6H_5$. On treatment with acetyl chloride, it yielded a thick, viscous oil of the composition $C_{10}H_{17}N(Ph)COMe$.

Fenchene was oxidised by heating it on the water bath with nitric acid (1 nitric acid : 1 water). When the oxidation was complete the liquid was distilled in steam, when some acetic acid was obtained. The residue was then evaporated to small bulk, and on standing crystals of cis-camphopyric acid separated out. After the removal of these crystals, the oily mother liquors were eventually distilled in vacuo. An acid oil and a neutral solid distilled over; these were separated by means of sodium carbonate, and the solid crystallised from alcohol. It proved to be camphopyric anhydride, m. p. 178°. The yield of camphopyric acid obtained in these experiments was about 20 per cent.

Turpentine hydrochloride was heated on the water bath with nitric acid (2 nitric : 1 water). The oxidation was exceedingly slow, but after about 10 days the bulk of the hydrochloride had disappeared. The greater part of the acid was then distilled and contained a considerable proportion of acetic acid. The residue was then evaporated to complete dryness, dissolved in ether and the ethereal solution extracted with sodium carbonate.

The acids extracted by the alkali were converted into insoluble lead salts. The lead salts were decomposed by sulphuric acid and extracted with ether. On evaporating the ether, an oil was obtained which on standing deposited crystals of camphoric acid; the purified acid melted at 202—203°, and its anhydride at 217°.

The oil left after separation of these crystals was distilled in a vacuum; an oil distilled over between 120—130°, a smaller portion at 130—150°, and a considerable amount at 180—200°, which solidified on standing. This latter portion was purified by sublimation and crystallisation from alcohol, and proved to be camphopyric anhydride, m. p. 178°.

The yield of camphoric acid from 300 grams of turpentine hydrochloride was 18 grams, and of camphopyric anhydride 8—9 grams. The authors were unable to isolate any camphoic acid.

4. "The action of alkalis on amides." By Julius B. Cohen, Ph.D., and Charles E. Brittain, B.Sc.

The authors have succeeded in preparing a series of compounds of the general formula $R'NH \cdot C_2H_3O \cdot NaOH$ and $R'NHC_2H_3O \cdot KOH$, by the action of the caustic alkalis on amides under certain conditions. These substances are analogous in their mode of formation and in properties to the alcoholates previously described (Cohen and Archdeacon, Trans., 1896, 69, 9), and probably possess a similar constitution, which

may be expressed by the formula

$$\begin{array}{c} R'-N-Na \\ Me \cdot C \begin{array}{l} \nearrow OH. \\ \searrow OH \end{array} \end{array}$$

5. "The formation of monomethylaniline from dimethylaniline." By Julius B. Cohen, Ph.D., and Harry T. Calvert, B.Sc.

When phenylnitrocarbinol (Trans., 1897, 71, 1050) acts on dimethylaniline, a violent reaction occurs and the dimethylaniline is converted into nitrosomethylaniline, and at the same time nitrogen is evolved and benzylalcohol and benzaldehyde are formed. As phenylnitrocarbinol readily evolves nitrous fumes on standing and reacts in some cases like nitrous acid, this result suggested the possibility of a similar reaction occurring when nitrogen trioxide acts upon dimethylaniline. The latter action is, however, entirely distinct from that of phenylnitrocarbinol or nitrous acid, and will form the subject of a future communication.

6. "Note on the aluminium-mercury couple." By Julius Cohen, Ph.D., and Harry T. Calvert, B.Sc.

The authors find that when aluminium is amalgamated with mercuric chloride, a small quantity of chlorine is retained by the aluminium and is probably present as oxychloride. The presence of the chlorine first became evident in the process of reducing a nitro-compound in neutral solution, when, instead of the free base, the hydrochloride was formed.

7. "Action of chloroform and alkaline hydroxides on the nitrobenzoic acids." By Walter J. Elliott, M.A.

The author finds that the meta- and para-acids are reduced to the corresponding azoxy-acids, while the ortho-acid is not appreciably affected.

ADDITIONS TO THE LIBRARY.

I. By Purchase.

Bancroft, W. D. The Phase Rule. Pp. viii + 255. New York 1897.

Berthelot, M. Thermochimie. Tome I. Les lois numériques. Pp. xvii + 737. Tome II. Les Données expérimentales. Pp. 878. Paris 1897.

Les Actualités Chimiques. Revue des progrès de la Chimie pure et appliquée, publiée sous la direction de M. Charles Friedel. Rédacteur G. F. Jaubert. Pp. 341. Paris 1896.

Donations.

Garrett, F. C., and Harden, A. An Elementary Course of Practical Organic Chemistry. Pp. viii + 72. London 1897.

From the Authors.

Wade, John. Introduction to the Study of Organic Chemistry. Pp. xvi + 460. London 1898.

From the Author.

At the next Meeting, on Thursday, February 3rd, the following Papers will be received. The author of that marked with an asterisk has announced his intention of being present.

"On the dissociation of potassium platinichloride in dilute solution, and the production of platinum monochloride. By E. Sonstadt.

"Effect of the mono-, di-, and tri-chloracetyl groups on the rotatory power of methylic and ethylic glycerates and tartrates." By Percy Frankland, F.R.S., and Thomas Stewart Patterson, Ph.D.

"The rotation of ethylic and methylic di-monochloracetyltartrates." By Percy Frankland, F.R.S., and Andrew Turnbull, Ph.D.

* "The volumetric estimation of sodium." By H. J. H. Fenton, M.A.

CERTIFICATES OF CANDIDATES FOR ELECTION.

N.B.—The names of those who sign from “General Knowledge” are printed in *italics*.

The following Candidates have been proposed for election. A ballot will be held on February 17th.

Allhusen, Ernest Lionel,

Geological Survey Offices, Perth, West Australia.

Geologist. Bachelor of Science (University of Durham), Honours in Chemistry and Geology. For some years Chemist to the Imitio Alkali Co., Ltd.

P. Phillips Bedson.

R. Greig Smith.

Saville Shaw.

F. E. Allhusen.

F. C. Garrett.

John M. Thomson.

Bailey, William Martin,

13, Green Lane Road, New Evington, Leicester.

Teacher of Science. Honours Practical Chemistry, 1st Class; Advanced Inorganic Theoretical, 1st Class; Advanced Inorganic Practical, 1st Class; Pass in Chemistry at Inter. Arts Exam., Royal Univ. Dublin. Pass in Chemistry at London Inter. Science.

Edgar E. Horwill.

E. Masters.

W. B. Hards.

W. H. Lewis.

Duncan T. Richards.

Brittain, Charles Edward,

11, Highfield, Scarborough.

Research Student in Chemistry at the Yorkshire College, Leeds, 1893–6. Student of Chemistry at Yorkshire College; Graduated B.Sc., Honours in Chemistry, Victoria University, 1896–7. Studied under Prof. Fittig in Strassburg. Last three months Research Student at Yorkshire College. Results of work are to be published shortly.

Arthur Smithells.

Reginald B. Brown.

Julius B. Cohen.

John McCrae.

Herbert Ingle.

Brooks, Cecil Joslin, A.I.C.,

24, Wood Street, Woolwich.

Metallurgical Chemist. Educated at King's College during the

Sessions 1892—1895. For some time as Assistant in a Chemical Laboratory. Has been engaged during the last two years as Chemist in Cement Works and in Lead Smelting and Desilverising Works.

John M. Thomson.

Patrick H. Kirkaldy.

Herbert Jackson.

William H. Sodeau.

Jas. K. Burbridge.

Bull, Benjamin Samuel,

49, Devonshire Road, Greenwich, S.E.

Chemist to Messrs. Wilkinson, Heywood and Clarke. M.A. and B.Sc. (University of New Zealand); Ph.D. (Munich), A.I.C.

Henry E. Armstrong.

Sidney Williamson.

F. Stanley Kipping.

Gerald T. Moody.

William J. Pope.

Burge, Charles Henry,

Iddesleigh, Crescent Road, Kingston Hill, S.W.

Analyst, Government Laboratory, W.C. Student at Royal College of Chemistry. Thirty years at the Laboratory, Somerset House. Fellow of the Institute of Chemistry.

T. E. Thorpe.

E. Grant Hooper.

R. Bannister.

C. Proctor.

H. J. Helm.

J. H. Robbins.

J. Woodward.

Caldecott, William Arthur,

Box 1891, Rand Central Ore Reduction Co., Ltd., Johannesburg, South African Republic.

Metallurgical Chemist. B.A. (Cape of Good Hope University). Member Soc. of Chem. Ind. and of Chemical and Metallurgical Soc. of S. Africa. Author of "Smelting and Refining of Cyanide Bullion" (Jan., 1897, S.C.I.), and "Relative Efficiency of Strong and Weak Cyanide Solutions for Dissolving Gold" (Proc. C. and M. of S. A.). Engaged for seven years in actual working of cyanide process and research connected therewith.

William Crookes.

Alfred James.

R. R. Tatlock.

H. T. Durant.

John S. McArthur.

Cannon, Matthew J.

101, The Chase, Clapham Common, S.W.

Analytical Chemist. Received a private training under my father, Matthew Cannon, F.C.S., conjointly with study at various Colleges and Institutions and also as a pupil of H. S. Carpenter, F.I.C., F.C.S. Have been engaged for 12 years as Assistant Chemist in the Acetic Acid Works

of Messrs. Beaufoy & Co., and for several years (1888—1891) I have been Demonstrator in the Laboratory (evening) of Onslow College, Chelsea. Recently studied Brewing Chemistry under John Heron, B.E., F.I.C., F.C.S., and have obtained highest place and silver medals both in the Ordinary and Honours Stage of the City and Guilds Examination in Brewing.

Matthew Cannon.

C. A. Mitchell.

John Wilson.

Walter J. Sykes.

John Heron.

Otto Hehner.

Cooper, Albert John Bullen,
Grimston Lawn, Ealing, W.

Student. Studied Theoretical and Practical Chemistry at the Pharmaceutical Society under Prof. Dunstan and Dr. Attfield during the Sessions 1891—1893. Worked at Practical Chemistry for one Session in l'École Supérieure de Pharmacie de Paris. From 1895 have been attending Classes in Mathematics, Physics, Physiology and Analytical Chemistry in King's College, London.

Wyndham R. Dunstan.

Herbert Jackson.

John Attfield.

Patrick H. Kirkaldy.

John M. Thomson.

W. D. Halliburton.

Cooper, John.

20, Derwentwater Road, Gateshead-on-Tyne.

Assistant Demonstrator in Chemistry. Student-Demonstrator Durham College of Science. Student of above College for four years. Formerly Assistant Chemist Messrs. Cochrane & Co., Iron Works, Middlesbrough. B.Sc., University of Durham. Friere Marreco Medallist in Chemistry, University of Durham.

P. Phillips Bedson.

R. Greig Smith.

F. C. Garrett.

Saville Shaw.

Wm. McConnell, Jun.

Cooper, William Ranson, M.A., B.Sc., A.I.C.,

87, Upper Tulse Hill, S.W.

Electro-Chemist. Studied Chemistry at King's College, London. Obtained the B.Sc. Degree at the Royal University of Ireland in Chemistry and Experimental Physics. Electro-chemical Assistant to Mr. James Swinburne during the last two years. Associate of the Institute of Chemistry.

John M. Thomson.

Herbert Jackson.

Henry E. Armstrong.

Patrick H. Kirkaldy.

James Swinburne.

Gerald T. Moody.

William H. Sodeau.

Cowling, Frederick,

Clay Cross, nr. Chesterfield.

Head Master, Technical Schools. Lecturer on Chemistry and Physics in the above schools. Sometime Demonstrator in Chemistry to Leicestershire County Council Technical Education Committee.

Edward Francis.

G. H. Major.

George Young.

Frank Clowes.

J. J. Sulborough.

Dodd, Frederick Robertson,

1, Wesley Street, Liverpool.

Analytical Chemist. Two years Student of Chemistry at Anderson's College, Glasgow. Six months in the Laboratory of Messrs. Wm. Brown, Sons & Co., Oil Merchants. Five and a half years Assistant to A. Smetham, Esq., F.I.C., F.C.S., &c. Associate of the Institute of Chemistry by examination (July, 1895).

Alfred Smetham.

William Ralston.

John B. Ashworth.

G. G. Henderson.

James Robson.

Matthew A. Parker.

Thomas Gray.

A. Humboldt Sexton.

Dootson, Frederick William, M.A.

Bryn, Glisson Road, Cambridge.

Assistant Demonstrator in the University Chem. Lab., Camb. Joint Author with W. J. Sell, M.A., of a paper on Citrazinic Acid (Journal of the Society, 1897).

G. D. Liveing.

W. J. Sell.

James Dewar.

H. J. H. Fenton.

Alexander Scott.

Edwards, Wilbraham Tollemache Arthur,

Reduit, Mauritius.

Analytical and Consulting Chemist. Member of the Royal Agricultural College, Cirencester. Fellow of the Institute of Chemistry of Great Britain. Assistant Director of the Agricultural Experiment Station (since Jan. 1893), Reduit, Mauritius.

L. Ehrmann.

John A. R. Newlands.

Edward Kinch.

B. E. R. Newlands.

Bernard Dyer.

Thos. Tyrer.

Boverton Redwood.

Fuerst, Jules,

23, Marlboro' Road, N.W.

Merchant. Fellow of the Royal Photographic Society. Author of

Book on Modern Developers. Lecturer on Orthochromatic and Animated Photography.

John Moss.

David Howard.

Thos. Tyrer.

T. Donald Watson.

A. F. Fuerst.

Gilderdale, Frederick,

3, Havelock Street, Newcastle-on-Tyne.

Chemist and Analyst. Chemist and Analyst for John Ismay & Sons, Manufacturing Chemists, Newcastle-on-Tyne.

Thomas Tyrer.

Jas. Baynes.

Francis Ransom.

John Pattinson.

W. Watson Will.

T. Donald Watson.

Gilles, William Setten,

"Coniston," Cedars Road, Beckenham, Kent.

Leathersellers' Company Research Fellow at Central Technical College. Associate of the City and Guilds Institute. Engaged in Research during past two years and Joint Author with Mr. F. F. Renwick of Notes in Chem. Soc. Proceedings.

Henry E. Armstrong.

F. Stanley Kipping.

Gerald T. Moody.

William J. Pope.

Sidney Williamson.

R. L. Jenks.

Glaister, John,

4, Grafton Place, Grafton Square, Glasgow.

Professor of Forensic Medicine and Public Health, St. Mungo's College, Glasgow. M.D., Glasg.; F.F.P.S. Glasg.; L.R.C.S., Ed.; L.R.C.P., Ed.; D.P.H., Camb. Teacher of Public Health Laboratory Instruction in Chemical Analyses, &c., St. Mary's College, Glasgow, for ten years past, which is recognised for graduation by Universities of Oxford and Cambridge, and the Scottish Colleges. Examiner in Forensic Medicine and Toxicology to Royal Colleges of Physicians and Surgeons of Edinburgh and Faculty of Physicians and Surgeons of Glasgow for past fifteen years; Examiner for Diplomas in Public Health to same Colleges, with special reference to Laboratory work and analysis.

W. Ivison Macadam.

R. R. Tatlock.

John Clark.

James M'Cutcheon.

T. Rhymer Marshall.

Hills, Thomas Herbert,

6, Eliot Park, Blackheath.

Chemical Manufacturer. Studied Chemistry (Theoretical and Prac-

tical) with Prof. Graham. Student in Chemistry at Royal College of Science, Kensington, under Prof. T. E. Thorpe. At present Manager of Messrs. F. C. Hills & Co., Chemical Works, Deptford, and East Greenwich.

T. E. Thorpe.

W. Palmer Wynne.

F. Napier Sutton.

W. A. S. Calder.

E. C. Thompson.

Homfray, David,

6, Dartmouth Row, Greenwich, S.E.

Analytical Chemist. Bachelor of Science (London University).
Fellow of the Institute of Chemistry.

C. T. Kingzett.

William Ramsay.

H. B. Dixon.

H. Wood Smith.

Robert Waterhouse.

McEwen, Atholl Francis,

43, Gilmore Road, Lewisham, S.E.

Metallurgical Chemist and Assayer. Nearly two years an Assistant in Laboratory of Incandescent Gas Light Co. For seven years Assistant to Edgar Jackson, Esq., F.I.C., A.R.S.M., &c. Went out to British Columbia on a three years' engagement, but just returned (owing to circumstances beyond control) after fifteen months' Mining work, with "Lillovet Fraser River and Cariboo Gold Fields."

W. Mackean.

Horatio Ballantyne.

R. R. Tatlock.

James Mactear.

Charles G. Cresswell.

Miller, John Edward,

Holmood, Patrington, Hull, Yorks.

Veterinary Surgeon. Member of the Royal College of Veterinary Surgeons, Studied Chemistry in Edinburgh: Official Inspector for the Board of Agriculture.

W. H. Coates.

M. D. Penney.

Jas. Baynes.

George Robertson.

William Fowler.

Mills, William Hobson,

Jesus College, Cambridge.

Student of Chemistry. B.A., late Scholar of Jesus College, Cambridge, First Class Natural Sciences Tripos, Part I. and Part II., working at organic research.

G. D. Liveing.

W. J. Sell.

Thomas H. Easterfield.

H. J. H. Fenton.

George Dixon.

Morgan, Gilbert Thomas,

35A, Russell Road, Kensington, W.

Assistant Demonstrator, Royal College of Science, London, S.W. Student in Chemistry, Technical College, Finsbury, 1886—89. Joint author with Professor Meldola, F.R.S., "On the constitution of Azo- and Diazo-derivatives," J.C.S., vol. lv. "Contributions to the Chemistry of the Azonaphthols," J.C.S., vol. lv. Research and Works Chemist, Read, Holliday & Sons, Limited, Huddersfield. Associate in Chemistry Royal College of Science, 1896. First Class Honours in Chemistry, B.Sc., London, 1896.

William A. Tilden.

R. Meldola.

W. Palmer Wynne.

Henry E. Roscoe.

Chapman Jones.

Moss, William Edward,

Burnthwaite, Bolton, Lancashire.

Millard Scholar in Natural Science at Trinity College, Oxford. Engaged in the study of Chemistry, and generally interested in its progress.

Richard J. Moss.

D. H. Nagel.

Percy Elford.

E. G. J. Hartley.

J. E. Marsh.

A. E. Tutton.

Poole, Herman,

323, W. 34th Street, New York City.

Manufacturing and Technical Chemist. Head Chemist, Grosselli Chem. Co., Cleveland, Ohio, 4 years, 1887—91. Inventor of Ferroid. Originator of the Poole Ointments. Inventor of Poole process of treating Aluminum Phosphate Rock. Chemist to Board of Health, Buffalo, N.Y., 1878. Translator of Scheurer-Kestner's "Pouvoir Calorifique de Combustibles." Translator for the *American Gaslight Journal*, N.Y. City. Author of paper on determination of fat and casein in fæces, read at Am. Chem. Soc. 1897 meeting. Manufacturer of purifying material for gas works. Long and varied experience in Analytical, Metallurgical, and Manufacturing Chemistry.

Peter T. Austen.

R. C. Woodcock.

James H. Stebbins, Jun.

E. G. Love.

Wm. Jay Schieffelin.

Pope, Thomas Henry,

South Street, Ponders End.

Associate of the City and Guilds Institute. Assistant in the Chemical Laboratory of Robert Mond, Esq.

Henry E. Armstrong.

William J. Pope.

Gerald T. Moody.

Sidney Williamson.

Arthur R. Ling.

Reid, James Brown,

6, Southfield Terrace, Skipton.

Chemist and Brewer. Student of Chemistry, Technical College, Glasgow.

G. G. Henderson.

James Robson.

Thomas Gray.

William Ralston.

Matthew A. Parker.

A. Humboldt Sexton.

Renwick, Frank Forster,

Glengall, Woodford Green, Essex.

Chemical Student at the Central Technical College, South Kensington. Holder of a Research Fellowship of the Leathersellers' Company. Joint author with Mr. W. S. Gilles of contributions to the Proceedings of the Chemical Society :—Proc. Chem. Soc., 1897, p. 64, and 1897, No. 92. A.C.G.I.

Henry E. Armstrong.

F. Stanley Kipping.

Gerald T. Moody.

William J. Pope.

Arthur Lapworth.

R. L. Jenks.

Reynolds, William Colebrook,

64, Lydford Road, Paddington, W.

Student. Studied Chemistry at Owens College⁷ (1890—1). Gained a National Scholarship, and in 1897 became an Associate of the Royal College of Science in Chemistry. Passed Inter. Sc. (London) with 1st Class Honours in Chemistry. Now working in the Research Laboratory of the Royal Coll. Sc.

William A. Tilden.

W. Palmer Wynne.

H. B. Dixon.

Chapman Jones.

M. O. Forster.

Richards, William,

Old Elvet, Durham.

Member of Durham University. On Organising Staff of Education Department of County Council. During the past three years, I have taken the course prescribed for undergraduates in Science of the Durham University. In the final examination for the title of A.Sc. (which examination I passed in June last), I took Chemistry, Inorganic and Organic, as one of the subjects. I have had experience in teaching Chemistry and Physics.

P. Phillips Bedson.

R. Greig Smith.

F. C. Garrett.

Saville Shaw.

G. P. Dodds.

Sayer, Harold Charles,

Devon Villa, Summerhill Road, Dartford.

Analyst in the Laboratory of Messrs. Burroughs, Wellcome and Co.'s Works, Dartford. Associate of the City and Guilds of London Institute. For four years a student in the Central Technical College.

Henry E. Armstrong.

William J. Pope.

David Johnson.

Sidney Williamson.

Gerald T. Moody.

F. Stanley Kipping.

Walker, Andrew Jamieson, B.A.,

Kilycadden, Killygordon, Co. Donegal.

Student in the Chemical Laboratory of the Univ. of Heidelberg. Lately Demonstrator of Chem. in Queen's College, Galway. For six years student of Chemistry and Physics in Queen's College, Galway, 1890—96. Senior scholar in Chemistry, 1893—4. Demonstrator, 1893—96. B.A. Royal Univ. of Ireland in Chem. and Physics. At present engaged in an investigation, suggested by the late Prof. Victor Meyer, on the constitution of the (*o*) and (*p*) Cyanophenols, in the Univ. of Heidelberg.

A. Senier.

Maxwell Simpson.

E. A. Letts.

J. Emerson Reynolds.

H. Lloyd Snape.

W. N. Hartley.

Weissmüller, Ernest Charles,

30, Pepys Road South, New Cross, London, S.E.

Junior Assistant Chemist. Studied for three years at City and Guilds Technical College, Finsbury, where certificate was gained. Afterwards Assistant Chemist to Mr. Cowper-Coles, 39, Victoria Street, Westminster, in Electro-Metallurgical investigations. Since October 1896, Junior Assistant Chemist to Scientific Dept. of the Imperial Institute, under Prof. W. R. Dunstan.

Wyndham R. Dunstan.

A. G. Bloxam.

R. Meldola.

Francis H. Carr.

R. L. Jenks.

Approved by Council under Bye-Law I. (3).

Don, John R., D.Sc., M.A.,

Waitaki Boys' High School, Oamaru, New Zealand.

Rector of the Boys' High School. Seven years Lecturer on Chemistry at the Dunedin Technical College, N.Z. Lecturer on General and Chemical Geology at the Otago University School of Mines, Dunedin.

A. Vernon Harcourt.

PROCEEDINGS
OF THE
CHEMICAL SOCIETY.
EDITED BY THE SECRETARIES.

No. 188.

Session 1897-8.

February 3rd, 1898. Professor Dewar, F.R.S., President, in the Chair.

Certificates were read for the first time in favour of Messrs. Charles Baskerville, North Carolina University, Chapel Hill, North Carolina; Alfred Campion, 637, Alexandra Parade, Dennistown, Glasgow; Robert Martin Caven, University College, Nottingham; F. Hudson-Cox, 67, Surrey Street, Sheffield; John Arnold Fleming, Britannia Pottery, Glasgow; Harry Pearson Hodgson, Caldew Bank, Cummersdale, Carlisle; Edwin Charles Jee, 45, Pepys Road, New Cross, S.E.; Edward Jones, Vine Cottage, Tudor Road, Kingston-on-Thames; Walter Ratcliffe, 21, Mawdsley Street, Bolton; Henry Somerville 33, Vincent Square, S.W.; Harry St. John, Thornfield, Sunderland.

Of the following papers those marked * were read :—

*8. "The volumetric estimation of sodium." By H. J. H. Fenton, M.A.

Dihydroxytartaric acid, in presence of dilute sulphuric acid, is readily oxidised by potassium permanganate at the ordinary temperature, the reaction affording a very convenient method for the estimation of the acid or its salts. A method has been devised for the quantitative estimation of sodium based upon this relation and upon the sparing solubility of sodium dihydroxytartrate. The solubility of the sodium salt at 0° is shown to be extremely small, and in presence of excess of a dihydroxytartrate is practically negligible.

The substance to be examined, in concentrated neutral solution, is mixed with excess of potassium dihydroxytartrate and the mixture is kept at 0° for half an hour. The precipitated sodium salt is washed

with a little ice-cold water, dissolved in excess of dilute sulphuric acid and titrated with potassium permanganate.

The results obtained with sodium sulphate, chloride, nitrate, acetate, and with rochelle salt, are accurate within 0.3 per cent. The presence of magnesium does not interfere with the accuracy of the results, but ammonium salts, if present in excess, lead to low results. Full details for working the process are given in the paper.

The potassium and ammonium salts of dihydroxytartaric acid have been prepared and examined, and, together with other derivatives of the acid, will be described in a future communication.

DISCUSSION.

Mr. HEHNER said that analysts would welcome the method. It was remarkable that sodium, the most widely distributed element, had hitherto been without a direct method of quantitative estimation. He would suggest that the process should be conducted gravimetrically.

Mr. NEWLANDS mentioned that he had at one time been accustomed to determine sodium as acid oxalate with approximate accuracy by titration either before or after incineration.

Dr. LAWSON asked how Mr. Fenton's method for the production of dioxytartaric acid compared, as regards yield, with that usually employed. The sodium salt was of technical importance in the preparation of a valuable dye-stuff, and it would be of interest to know whether the results were comparable with those obtained by decomposing nitrotartaric acid.

Mr. FENTON, in reply, said that he had suggested in the paper that the process might be conducted gravimetrically, but he considered that the volumetric method would find most favour. He had experimented with other sparingly soluble sodium salts, but did not think that any could nearly compare with the dihydroxytartrate as regards insolubility. In reply to Dr. Lawson, he said that the process possessed many advantages as compared with the usual method of preparing the sodium salt from nitrotartaric acid.

*9. "The atomic weight of boron." By F. P. Armitage.

The determination of the water of crystallisation was the method used. The values for the ratio $\text{Na}_2\text{B}_4\text{O}_7 : \text{H}_2\text{O}$ obtained by previous workers are not sufficiently concordant to allow of the values for the atomic weight of boron, calculated from them, being regarded as very trustworthy. The discrepancies are probably to be traced to the slight efflorescence which occurs during the preliminary drying of the crystals of borax. A new method of drying was consequently applied, the borax being washed with alcohol and ether successively, and the ether expelled by exposure for 6 hours in a vacuum. A given weight

of the dry crystals was dehydrated in a stream of air, the final traces of water being expelled by fusion over the Bunsen burner and not over the blowpipe.

In a series of six experiments, the greatest difference in the percentage value for the water of crystallisation was 0.413, and the mean atomic weight of the element as calculated from these values 10.959, a number differing by 0.006 from that recently obtained by Ramsay and Aston in their experiments on the distillation of sodium diborate with hydrochloric acid and methyl alcohol.

Certain results are also given in which the method of titration (*c.f.* Rimbach, *Ber.*, 1893, 26, 164) is applied with a view of ascertaining the possible degree of its accuracy. Thus, a given weight of fused borax was dissolved in water and titrated with dilute sulphuric acid, the strength of which had been determined (i) by titration with solution of pure soda of known strength, (ii) as barium sulphate. The value 10.928 was obtained for the atomic weight of boron as a mean of two experiments performed by this method.

DISCUSSION.

MR. VELEY said that methods of determination of atomic weights based upon the elimination of water from a crystalline salt presented the difficulties, firstly, of the mechanical inclusion of water within the walls of the crystals, however fine, and, secondly, of the possible efflorescence and deliquescence of such salts. These difficulties, as also that of the intumescence of the anhydrous salt, when heated with the blowpipe, induced Ramsay and Aston to reject this method. It appeared that the author had overcome these difficulties to a great extent by removing the adherent water by washing with absolute alcohol and subsequently with ether, which was pumped off, as also by heating the anhydrous salt only at a temperature obtained by the Bunsen burner, and not at that of the blowpipe, when loss occurred either on account of the volatilisation or the decomposition of the borax. The experiments of the author also showed that the method of determining the atomic weight, proposed by Rimbach, though not of the degree of exactitude necessary for such determinations, was probably more accurate for the purpose of acidimetry than that of sodium carbonate, which was not readily obtained of the composition required by its molecular formula.

MR. GROVES asked whether the volatilisation observed when the crucible was heated in the blowpipe flame might not be due to the action of water vapour and carbonic anhydride which would diffuse through the perforated cover.

DR. SCOTT was astonished that any one now should attempt to determine atomic weights through calculations of the amount of

water of crystallisation contained in hydrated salts. The experiments of J. W. Mallet on ammonia alum and of many other experimenters had shown how unsatisfactory such determinations must always be. It was evident that as such salts produced a determinate vapour pressure of water depending on the temperature, if the air in which they were dried contained less than that amount the salt must lose water during its drying.

The PRESIDENT considered it superfluous to record weighings to six places and the atomic weight to three places of decimals, having regard to the method adopted. With reference to the process employed by the author in drying the borax, he failed to understand why, if borax is an efflorescent salt, it loses no water of hydration when washed with absolute alcohol. He suggested that in investigating this point the influence of time should be taken into account.

Mr. ARMITAGE, in reply, said that he had not examined the sublimate formed on the lid of the crucible when ignited with the blowpipe, as his object was to show merely that a loss of weight would occur if this method is adopted. The standard of atomic weight taken was oxygen = 16. The time occupied for each washing by absolute alcohol was 3—4 minutes.

***10. "Rate of escape of ammonia from aqueous solution." By E. P. Perman, D.Sc.**

If a current of air is drawn through a dilute aqueous solution of ammonia at a uniform rate, the amount of ammonia q in solution when a volume V of air has passed through the solution, is accurately represented by the equation $\log q = a - bV$, a and b being constants. The volume of air was measured by a meter.

The equation does not express the results given by a concentrated solution; the solution used in most of the experiments contained 70 grams of ammonia per litre.

A number of experiments, conducted at different temperatures, prove that the logarithmic formula holds good between 0° and 46° ; it was also found to hold good when the pressure was varied.

The value of b is a measure of the rate of escape of the gas from the solution under any specified conditions; such values were obtained at various temperatures, and a simple connection was found between b and temperature t° , viz., $\log b = a + \beta t$, a and β being constants. Combining the two logarithmic equations,

$$\log q = a - y, \text{ if } \log y = a + \log V + \beta t.$$

From this expression the amount of ammonia left in a solution after a certain volume of air has been drawn through it can be at once calculated, provided that, at the beginning of the aspiration, the strength of the solution was not much greater than that mentioned above.

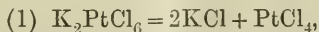
DISCUSSION.

The PRESIDENT remarked that the subject investigated by the author was a very complicated one. He thought that the variations in the tension of the ammonia solution used in the experiments should be determined, as a valuable addition to the paper. It was probable that the results would be expressed by the equation— $\log p = A - B/T$ —where A and B are constants and T is the absolute temperature, which was applicable to many similar cases.

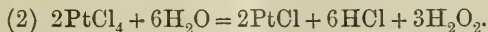
Dr. PERMAN, in reply to a question by Mr. Groves, stated that the conditions of volatilisation of ammonia from the solution had been varied by using flasks of different capacities and tubes of different diameters. In reply to Dr. Wilderman, he said that he considered that his results confirmed Henry's law for ammonia in dilute solution. In reply to the President, the author said he had found approximately the vapour-pressure of the ammonia solution used in most of the experiments at a temperature of 20° ; it was about 70 mm. although he had not found the vapour-pressure of solutions of different strengths, but intended to do so. He regarded the method of expressing the results given in his paper as the most convenient for the present, though as yet it was only empirical.

11. "On the dissociation of potassium platinichloride in dilute solution: and the production of platinum monochloride." By E. Sonstadt.

A solution of potassium platinichloride in 1000 parts of water undergoes no sensible change on heating for an hour or two. But a solution in 10,000 parts of water becomes turbid almost immediately on heating, and the turbidity increases until, after some hours, the liquid becomes nearly opaque. On continuing the heating for some days, water being added from time to time to maintain the bulk, a sediment forms and the liquid partially clears. By increasing the quantity of water during the heating, the clearance is facilitated. The reactions that take place are, first, the dissociation of the potassium platinichloride;



and then the decomposition of the platinic chloride, with formation of platinum monochloride (PtCl or Pt_2Cl_2) hydrochloric acid, and hydrogen peroxide, thus:



The yellow, non-crystalline precipitate of hydrated platinum monochloride is difficult to collect, for it passes through the filter until the pores are clogged, and then the filtration is exceedingly slow. The precipitate should not be dried on the filter, but washed off, as far as

possible, into a dish, and the water evaporated. When dried on the water bath, the salt is brown; it still retains water, the last traces of which can scarcely be expelled before incipient decomposition begins; the anhydrous salt is black, or nearly so.

The clear filtrate, when concentrated, is strongly acid, and on drying and dissolving the residue in a little water, potassium chloride may be crystallised out. There is also a small proportion of potassium platinum-chloride, which may be either a portion of the original salt that has escaped decomposition, or may have been formed by a reverse action due to solution of the monochloride in the hydrochloric acid set free as described, in presence of hydrogen peroxide and air.

The hydrated salt, when treated on the water bath with strong soda solution, turns brown, and dissolves to a slight extent. But the brown residue is only partially dehydrated, and recovers its original colour after washing and exposure. The soda solution deposits the unchanged salt on dilution and long exposure to the air. It dissolves readily in hydrochloric acid; slightly in hot dilute sulphuric acid, apparently without decomposition; in moderately dilute nitric acid, used in large proportion, it dissolves to a deep brown liquid, which, evaporated to dryness on the water bath until no acid odour is perceptible, leaves a dark brown residue. This dissolves in hot water to a clear, dark brown liquid, which, on further heating, suddenly deposits the whole of the original salt, less any impurities present, which remain in the solution. The precipitate, when collected on a filter, is deeper coloured than before, being of an orange tint. The filtrate is free from platinum; but on continued washing with water, the salt dissolves slightly, and the filtered liquid becomes clouded.

Advantage was taken of this process of purification to obtain the monochloride for analysis. An attempt to analyse about 0.1 gram of the salt partially failed, owing to the presence of impurities taken up from the enormous proportion of distilled water used in its preparation. The monochloride, purified as described, was washed into a dish, and after drying on the water bath, was transferred to a small porcelain crucible. The salt weighed 0.2575 gram. The crucible was cautiously heated, with frequent application of the cold lid. Traces of nitric acid came off as well as water. When moisture ceased to be given off, the salt weighed 0.2315 gram. It was then more strongly heated, when chlorine came off and a final trace of water. The heat was then raised until the decomposition was complete. The platinum obtained weighed 0.1945 gram, which corresponds to 0.229 PtCl, a result which may be considered fairly satisfactory.

It might be supposed that platonic chloride itself, instead of dissociated from potassium chloride as in the described process, would be preferable, when it is desired to obtain platinum monochloride.

But the presence of free acid in the best-dried specimens of platinic chloride renders it unfit for the purpose. A specially dried specimen of platinic chloride dissolved in 10,000 parts of water gave a barely perceptible reaction. With 15,000 parts of water, after heating for some hours, the liquid became turbid, and gave a slight deposit, but not equivalent to that obtainable from a corresponding solution of potassium platinichloride. If, however, a solution of platinic chloride be evaporated on the water bath with nitric acid, the residue dissolved in water, and the solution evaporated again two or three times, the platinic chloride is not appreciably decomposed, but retains a little nitric acid instead of the hydrochloric acid with which it is otherwise associated. A solution of platinic chloride thus prepared, heated in 5,000 parts of water, gives a distinct turbidity, but the reaction is more nearly complete with double that proportion of water. The precipitate differs slightly in its properties from that obtained from the potassium salt; it is of a deeper tint, and is but slightly soluble in nitric acid. When treated with nitric acid and the solution evaporated over the undissolved portion, a weak solution only is obtained on adding water, which, on concentrating, deposits the salt, but not instantaneously. After evaporating the aqueous solution, the hydrate of platinum monochloride is insoluble in water, except, as in the former case, on continued washing. A specimen of the hydrate thus obtained weighed after drying on the water-bath, 0.1700 gram; when anhydrous, it weighed 0.1549 gram, and after expulsion of the chlorine by ignition 0.1316 gram of platinum remained. Theory requires from this quantity of platinum 0.1552 gram PtCl .

The potassium platinichloride used in the experiments had been several times recrystallised, and was perfectly free from acid. The yield of platinum monochloride was about five-eighths of that theoretically obtainable.

The author has made some experiments with the view of directly proving the presence of hydrogen peroxide in the liquid, though, considering the conditions of dilution and temperature, the quantity present at any time must be exceedingly small—the total amount produced according to the equation, assuming the reaction to be complete, being in the proportion of from 1:100,000 to 1:150,000 to the liquid present. In a solution that had been heated for five days, the author, using the chromic acid and ether test, obtained a faint coloration, hardly visible except to an observer of great sensitiveness. The author then prepared a solution in about 15,000 parts of water of some very pure crystals of potassium platinichloride (a previous trial with a salt of only ordinary purity having failed), and heated the solution for several hours at a temperature slightly below 70° . There was only a slight turbidity, for the temperature was too low for good

progress. On testing the solution the next day, a faint, bluish tint in the ether was perceptible. That hydrochloric acid is a product of the reaction was proved as follows. A hot, strong solution of potassium platinichloride was poured into a large quantity of a nearly saturated solution of pure potassium chloride. The precipitated platinichloride was collected, well washed with water, and afterwards with alcohol, and dried on the water bath. A solution of about one part of this salt to 10,000 of water was heated for five days, the precipitate allowed to settle, and filtered off. A portion of the solution was concentrated in an open dish to about one-fifth of its bulk, and was then distilled. Silver nitrate added to the distillate gave a precipitate of silver chloride insoluble in nitric acid.

12. "Effect of the mono-, di-, and tri-chloracetyl groups on the rotatory power of methylic and ethylic glycerates and tartrates."
By Percy Frankland, F.R.S., and Thomas Stewart Patterson, Ph.D.

With a view of ascertaining the rotatory effect of the halogens when attached at a point in the molecule remote from the asymmetric carbon-atom, the authors have introduced the mono-, di-, and tri-chloracetyl groups into the methylic and ethylic tartrates and glycerates. This was effected by acting in each case with the acid chloride on the ethereal tartrate and glycerate respectively. The acid chlorides were in all cases prepared by heating the halogen-substituted acetic acid with phosphoric anhydride in a current of hydrochloric acid. Two acidyl groups were in all cases introduced, excepting in that of trichloracetyl, of which only one equivalent could be made to substitute in methylic and ethylic tartrates, whilst two equivalents reacted with the corresponding glycerates.

The rotations were in all cases determined at several different temperatures so as to ascertain the influence of the latter.

The results are summarised in the following table:—

	$[\alpha]_D^{15^\circ}$	$[\alpha]_D^{100^\circ}$	
Methylic glycerate	-4·80°	-8·31°*	(calculated).
„ diacetyl-glycerate	-12·04	-19·24*	(calculated). [43—44°.
„ di-monochloracetyl-glycerate..	-12·91	-17·99	b. p. 197° (15 mm.); m. p.
„ di-dichloracetyl-glycerate.....	-13·96	-17·18	b. p. 207° (20 mm.).
„ di-trichloracetyl-glycerate ...	-14·20	-15·30	b. p. 199—200° (15 mm.).
Ethylic glycerate	-9·18	-12·55*	(calculated).
„ diacetyl-glycerate.....	-16·31	-23·09*	(calculated).
„ di-monochloracetyl-glycerate...	-16·80	-22·08	b. p. 198° (15 mm.).
„ di-dichloracetyl-glycerate	-18·20	-21·10	b. p. 203° (15 mm.).
„ di-trichloracetyl-glycerate	-18·70	-18·40	b. p. 202° (15 mm.).

* These values for $[\alpha]_D$ at 100° for methylic and ethylic glycerates and diacetyl-glycerates have been calculated from the data given in a paper by P. Frankland and MacGregor (Trans., 1894, 65, 768).

	$[\alpha]_D^{30^\circ}$	$[\alpha]_D^{100^\circ}$	
Methylic tartrate	+2.14 ²	+5.99°	m. p. 48°.
„ diacetyltartrate.....	— *	—	m. p. 103.
„ di-monochloracetyltartrate ...	-0.62	+2.57	b.p. 217° (18 mm.) ; m. p. 55.
„ di-dichloracetyltartrate	+11.9	+10.9	b.p. 220—221° (15 mm.) ; m. p.
„ mono-trichloracetyltartrate...	+8.4	+10.15	m.p. 79—80°. [64—65°.
Ethylic tartrate.....	+7.66	+13.29	
„ diacetyltartrate	—†	—	m. p. 66.5°.
„ di-monochloracetyltartrate ‡...	+7.67	+11.81	b. p. 217° (15 mm.) ; m.p. 27.
„ di-dichloracetyltartrate	+16.3	+17.08	b. p. 225° (15 mm.).
„ mono-trichloracetyltartrate ...	+15.5	+17.6	b. p. 185° (16 mm.).

Methylic and ethylic di-monochloracetyltartrates have also been prepared by Freundler (*Bull. soc. chim.*, 1895, [3], 13, 1055—1063), who only obtained them as liquids with the following rotatory powers:—

Methylic di-monochloracetyl tartrate $[\alpha]_D^{18^\circ} = +3.5^\circ$

Ethylic „ „ $[\alpha]_D^{15^\circ} = +9.4^\circ$

In consequence of this discrepancy between Freundler's results and those of the authors, these two compounds have been prepared again (see next abstract), with the result that the authors' figures have been confirmed.

13. "The rotation of ethylic and methylic di-monochloracetyltartrates." By Percy Frankland, F.R.S., and Andrew Turnbull, Ph.D.

The ethylic compound has been again twice prepared by the authors, using different proportions of monochloracetylchloride and ethylic tartrate:—

First preparation, $[\alpha]_D^{20^\circ} = +7.90^\circ$.

Second „ „ $[\alpha]_D^{20^\circ} = +7.76^\circ$.

The substance subsequently crystallised (m. p. 27°), after which the rotation $[\alpha]_D^{20^\circ} = +7.61^\circ$ was found.

The methylic compound was also prepared, and again gave the m. p. 55°; the rotation was $[\alpha]_D^{20^\circ} = -0.68^\circ$.

Thus the results obtained with both compounds by one of the authors (see previous abstract) were confirmed, whilst additional evidence of their accuracy was afforded by the ethylic compound being obtained in the crystalline state.

Ethylic mono-monochloracetyltartrate in a state approaching purity was also prepared, and it was found to possess a considerably higher dextrorotation than the corresponding di-acidyl compound, thus $[\alpha]_D^{20^\circ} = +11.44^\circ$.

* $[\alpha]_D^{25^\circ} = -15.1^\circ$ (in absolute alcoholic solution).

† $\alpha_D = +5^\circ$ ($l=25$, $l=1$).

‡ See next abstract.

It is, therefore, inferred that the higher figures obtained by Freundler may have been due to the presence of monacidyl compounds, and this is borne out by the lower densities and boiling points which he records.

ADDITIONS TO THE LIBRARY.

I. *By Purchase.*

Boyle. Some Considerations Touching the Usefulness of Experimental Natural Philosophy. First Part: On its usefulness in reference to the minde of man. Pp. 127. Second Part: Of its usefulness to Physik. Pp. 417. Oxford 1663.

Campredon, L. Guide pratique du Chimiste Métallurgiste et de l'Essayeur. Pp. iv + 808. Paris 1898.

Du Clos. Observationes super aquis mineralibus Galliae. Leiden 1685. One volume with:—

Lister, Martin. Thermarum ac Fontium Angliae. Leiden 1686.

Nietzki, Rudolf. Chemie der Organischen Farbstoffe. Dritte vermehrte Auflage. Pp. x + 343. Berlin 1897.

II. *Donations.*

Bolas, Thomas. Glass Blowing and Working, for Amateurs, Experimentalists and Technicians. Pp. 212. London 1898.

From the Author.

Patents for Inventions, Abridgments of Specifications. Class I. Acids, Alkalies, Oxides, and Salts. Inorganic. Periods 1884—88. London 1896.

From the Patent Office.

Royal Society, The Record of the. No. 1. 1897. Pp. vi + 224. London 1897.

From the Royal Society.

Royal Society, Yearbook of the, 1896—97. No. 1. London 1897.

From the Royal Society.

Pamphlets.

Don, J. R. The Genesis of certain Auriferous Lodes. Pp. 105. Read before the American Institute of Mining Engineers. February, 1897.

From the Author.

Headden, W. P. Some Products found in the Hearth of an old Furnace upon the dismantling of the Trethellan Tin Works, Truro, Cornwall. (Read before the Colorado Scientific Society, November, 1897).

From the Author.

Mallet, J. W. On the Solubility of Ammonia in Water at Temperatures below 0°C.

— Note on a somewhat remarkable case of the rapid Polymerisation of Chloral. (Reprinted from the *American Chemical Journal*, vol. xix. 1897). From the Author.

Manch, R. Ueber die Löslichkeit von Alkaloiden, Glykosiden und Bitterstoffen in concentrirter wässriger Chloralhydratlösung und die Verwerthung des Chloralhydrats in der toxikologischen Analyse. Pp. 26. Strassburg 1897. From the Author.

Schaer, E. Arzneipflanzen als Fischgifte. Pp. 65. Strassburg. 1897. From the Author.

Speyers, C. L. Molecular Weights of some Carbon Compounds in Solution. (Reprinted from the *Journal of Physical Chemistry*, December, 1897). From the Author.

Symons, Brenton. A Geological Sketch of the Coolgardie Goldfields. Pp. 49. London, 1896. From the Author.

Woodward, H. B., F.R.S. A Memoir of Thomas Beesley, J.P., F.C.S. Warwick 1897. From the Author.

Zenetti, Paul. Mikrokrystallinische Niederschläge der Pikrinsäure mit Alkaloiden. Strassburg 1897. From the Author.

At the next meeting, on February 17th, there will be a ballot for the election of Fellows, and the following papers will be read.

"Observations on the influence of the silent discharge on atmospheric air." By W. A. Shenstone and W. T. Evans.

"Some lecture experiments." By J. Tudor Cundall, B.Sc.

"On the condensation of formaldehyde with ethylic malonate: and on cis- and trans-tetramethylenedicarboxylic acid." By E. Haworth and W. H. Perkin, junr., F.R.S.

PROCEEDINGS
OF THE
CHEMICAL SOCIETY.
EDITED BY THE SECRETARIES.

No. 189.

Session 1897-8.

February 17th, 1898. Professor Dewar, F.R.S., President, in the Chair.

Messrs. George F. Merson and Ernest H. Roberts were formally admitted Fellows of the Society.

STATEMENT BY THE COUNCIL.

The PRESIDENT said he was authorised by the Council to make the following statement to the Society :—

The following letter has been received by the Council :—

Letter received by the PRESIDENT from MESSRS. HARDEN *and* HARTOG.

THE OWENS COLLEGE, MANCHESTER, *Jan. 26th*, 1898.

DEAR SIR,—We beg to acknowledge the receipt of your letter of the 22nd inst. with reference to the Memorial which we had the honour of transmitting to yourself as President, and to the Council, of the Chemical Society, and to offer you our thanks in the name of the Memorialists for the consideration which it has already received.

We desire to point out that although it was not expressly so stated in the Memorial, it was obviously the wish of the signatories, if the Council had not at present the power to propose an alteration of Bye-Law V. in the sense suggested, that it should take the steps necessary to obtain that power. We gratefully recognise, therefore, the further consideration which the Council is now giving to this aspect of the question.

Would it be possible for us to be informed if it is the intention of the Council to make a definite statement with regard to the questions

raised in sufficient time for the matter to be brought before the Anniversary Meeting for this year?

We are, dear Sir,

Your obedient servants,

ARTHUR HARDEN.

PHILIP HARTOG.

Professor JAMES DEWAR, F.R.S., &c., &c.,
President of the Chemical Society.

The following reply had been sent that evening :—

Answer of Council.

CHEMICAL SOCIETY,

BURLINGTON HOUSE, W.

Feb. 17, 1898.

DEAR SIRS,—The Council desire me to thank you for your letter of the 26th January.

Since the presentation of the Memorial and the receipt of your letter of the 16th December, the question of the Society applying for a Supplemental Charter to enable votes at General Meetings to be given by proxy has received the anxious consideration of the Council, and in view thereof the Council has taken further legal advice on the matter.

The Council has this evening directed the President to make an announcement to the Society, which will be printed in the next Proceedings.

I am, dear Sirs,

Your obedient servant,

JAMES DEWAR,

President.

Messrs. HARDEN and HARTOG.

Report of the Council.

“The Council has submitted the question of a Supplemental Charter for legal opinion. The following was the case submitted :—

Case for the Opinion of Counsel.

On the 6th December last Counsel advised the President and Council of the Chemical Society whether under the Charter of such Society they had power to alter the Bye-Laws so as to provide for the

Votes at General Meetings being given by proxy. The case then laid before Counsel and his opinion thereon are sent herewith.

The Memorial referred to in the case has now been presented to the President and Council. It was signed by over 500 Fellows or about one-quarter of the total number. A copy thereof is sent herewith.

Together with the Memorial a letter dated the 15th December 1897 was received from Mr. Arthur Harden and Mr. Philip Hartog a copy of which is also sent herewith.

Such letter contains the following passage.

With reference to the substance of the Memorial we wish to make one statement. We are aware that in the Charter (on page 8 of the printed text) it is provided that "at all general meetings and meetings of the Council the majority present and having the right to vote thereat respectively shall decide upon the matters propounded at such meetings" hence in order to render legal the change desired it would probably be necessary to obtain a Supplemental Charter allowing members not actually present at meetings to vote by means of balloting papers. It is in this connection material to point out that in order to obtain a revision of Bye-Laws precisely similar to that now desired by Fellows of our own Society a Supplemental Charter was quite recently obtained by the Institution of Civil Engineers.

It is upon the question of a Supplemental Charter that the opinion of Counsel is now desired.

Enquiries have been made with reference to the Supplemental Charter obtained by the Institution of Civil Engineers referred to in the above mentioned letter. Such Supplemental Charter was obtained in March 1896 and a printed copy thereof together with a copy of the original Charter and Bye-Laws of such Institution is sent herewith.

It appears that the circumstances under which that Supplemental Charter was granted were not analogous to the facts connected with the Chemical Society and it is questionable whether that case can be regarded as a precedent in favour of granting a Supplemental Charter to such Society provided the Society as a whole should decide to present a petition for one.

In the first place the members of the Institution of Civil Engineers were unanimous in desiring the change. In the present case it is believed that the Fellows are not unanimous on the question and it is not at present known whether even a majority desire the change.

Secondly the objects of the Chemical Society and of the Institution of Civil Engineers respectively are wholly different.

The object of the Chemical Society shortly stated is the general

advancement of Chemical Science by the holding of Meetings at which new discoveries are brought under discussion and the results made known to the public in a series of Transactions.

It is a purely scientific Society and in no sense professional and in this respect resembles rather the Royal Society the constitution of which requires the presence of Fellows at general meetings to enable them to vote.

The object of the Institution of Civil Engineers on the other hand is not merely for the general advancement of Mechanical Science it is "more particularly for promoting the acquisition of that species of "knowledge which constitutes the profession of a Civil Engineer." It holds examinations for the admission of persons desirous of becoming Associate Members and is to a large extent a body exercising administrative functions with respect to a particular profession all over the Kingdom. Obviously therefore the considerations which would induce the Authorities to vary the regulation and management of such a body as the Institution of Civil Engineers would not be applicable in the case of a purely Scientific Society.

Thirdly the reasons advanced for granting the Supplemental Charter to the Institution of Civil Engineers do not exist in the case of the Chemical Society. The Institution of Civil Engineers stated in the Petition for such Supplemental Charter whereas when their Charter was granted (in 1828) the number of Members of all classes was 156 that :—

On the 2nd day of January 1896 the number of Members of all classes was 5969 the prescribed number of members of the Council is no longer sufficient to enable the institution to place on the Council an adequate number of representative men having regard to the total number of members and the scope of all branches of engineering science as now taught and practised throughout the realm and the number of members residing in or near the Metropolis now forms a comparatively small portion of the whole number and a large proportion cannot now be reasonably expected personally to attend General Meetings &c. &c.

In the case of the Chemical Society it cannot be alleged that the number of the Members of the Council is inadequate having regard to the total number of the Fellows the present number being 37 (including 15 vice-presidents who have been presidents) out of a total number of about 2100 Fellows. Under the existing Bye-Laws of the Institution of Civil Engineers the number of the Council "shall not be less than 23 nor more than 31" the total number of members of all classes of such Institution being at the present time about 6900.

It cannot be alleged that the Council of the Chemical Society has not contained from its foundation an adequate number of representative men. In fact the Memorial in favour of an alteration in the Bye-Laws states :—

It is of course recognised that a custom has grown up of choosing a certain proportion of the officers and Council from among the Fellows who reside in the provinces.

It cannot be alleged that the number of Fellows of the Chemical Society residing in or near the Metropolis forms a comparatively small portion of the whole number or that a large proportion cannot now be reasonably expected personally to attend General Meetings. There has not in recent years been any material increase * in the proportion of the number of Fellows who do not reside in or near the Metropolis as compared with the whole body and there is the further fact that whereas the object of the Society above mentioned has remained unchanged since the date of its charter in 1849 means of transit and communication with the other parts of the Kingdom have since that date become greatly facilitated.

So far as is known there is no case in which a Supplemental Charter has been granted to an old scientific Society on the question of voting by proxy alone where that question has not involved other considerations than the mere question of attendance of the members thereof at General Meeting even if such body was unanimous in desiring a change in its constitution for this purpose.

Counsel is requested to advise the President and Council of the Chemical Society as to the chances of success of obtaining a Supplemental Charter.

- 1 If the Fellows were unanimous.
- 2 If there were a majority of the Fellows in favour of the proposed change and the minority took no active steps to oppose.

* STATISTICS OF THE SOCIETY.

No. of Fellows.		Resident in London District.		Not resident in Great Britain and Ireland.		Country Members.	
		Per cent.		Per cent.		Per cent.	
1869	526	241	45	27	5	258	49
1871	550	255	46	36	5	269	50
1881	1090	461	42	113	10	516	48
1891	1840	625	34	289	16	926	50
1897	2100	700	33	322	16	1078	51

3 If there should be active opposition on the part of a minority of the Fellows.

4 If there were only a minority of the Fellows in favour of the change.

Also 5 How the majority for or against the change is to be ascertained. Must it be a majority of the whole of the Fellows or a majority of those voting at a General Meeting.

The following is the opinion of Counsel.

Copy of Opinion of Mr. COZENS-HARDY, Q.C.

Opinion.

1 2 3 and 4. The questions raised in this case are not really questions of law and I do not feel that any opinion I can give as to the chances of success of obtaining a Supplemental Charter can be of any value. But I may say that I think it highly improbable that the Government department before whom the application must come would be disposed to listen to the application unless it represented the practically unanimous view of the Fellows and that any active opposition by even a small minority would probably be fatal. The propriety of allowing votes by proxy or by voting papers transmitted through the post is obviously open to reasonable doubt. It is not easy to alter the constitution of a body of this nature except to give effect to the practically unanimous wish of the Corporators. I may add that the Supplemental Charter granted in 1895 to the Institution of Civil Engineers does not really furnish a precedent applicable to the present case. That Charter dealt with various important matters of which the allowance of proxy votes or voting papers was only one. I understand also that there was no difference of opinion on the part of the Fellows of that Institution.

5. In considering whether the Fellows really desire the change proposed I think regard must not be had only to those who are present in person at a meeting but in some other way the wishes of the whole body must be ascertained.

HERBERT H. COZENS-HARDY.

7 New Square, Lincoln's Inn,
February 4, 1898.

It was announced that the following changes in the Officers and Council were proposed by the Council:—

As *Vice-Presidents*—Professor Liveing, F.R.S., and Professor J. M. Thomson, F.R.S., *vice* Mr. Ludwig Mond, F.R.S., and Professor Roberts-Austen, C.B., F.R.S.

As *Hon. Secretary*—Dr. W. P. Wynne, F.R.S., *vice* Professor J. M. Thomson, F.R.S.

As *Ordinary Members of Council*—Messrs. E. J. Bevan, H. J. Fenton, W. Gowland, and David Howard, *vice* Messrs. B. H. Brough, J. W. Rodger, T. K. Rose, and Professor Sydney Young.

Certificates were read for the first time in favour of Messrs. Albert Abbot, B.A., Church Street, Adlington, Chorley; Henry William Coupe-Annable, University College, Sheffield; William Thomas Gidden, 108, Vicarage Road, Langley, Birmingham; Alexander Guthrie, B.Sc., Bocking, Braintree, Essex; John Heaton, 81, Garmoyle Road, Liverpool; John Shearson Hyland, Ph.D., M.A., 11, Powis Square, Bayswater; William Jones, 29, High Street, Wavertree, Liverpool; Thomas Martin Lowry, B.Sc., 28, St. Lawrence Road, N. Kensington, W.; Albert Henry Mitchell, Martins Lane, Tiverton; Alfred James Parker, 21, East Hill, Dartford, Kent; Samuel Walker, M.A., B.Sc., 126, Gilmore Place, Edinburgh; Samuel Allinson Woodhead, B.Sc., Agricultural College, Uckfield.

A ballot for the election of Fellows was held, and the following were subsequently declared duly elected.

Messrs. Ernest Lionel Allhusen, B.Sc.; William Martin Bailey; Charles Edward Brittain, B.Sc.; Cecil Joslin Brooks; Benjamin S. Bull, M.A., B.Sc., Ph.D.; Charles Henry Burge; William Arthur Caldecott, B.A.; Matthew J. Cannon; Albert John Bullen Cooper; John Cooper, B.Sc.; William R. Cooper, M.A., B.Sc.; Frederick Cowling; Frederick Robertson Dodd; John R. Don, D.Sc., M.A.; Frederick W. Dootson, M.A.; Wilbraham T. A. Edwards; Frederick Gilderdale; William Setten Gilles; John Glaister, M.D.; Thomas Herbert Hills; David Homfray, B.Sc.; Atholl Francis McEwen; William Hobson Mills, B.A.; Gilbert Thomas Morgan; William Edward Moss; Herman Poole; Thomas Henry Pope; James Brown Reid; Frank Forster Renwick; William Colebrook Reynolds; William Richards; Harold Charles Sayer; Andrew Jamieson Walker, B.A.; Ernest Charles Weissmüller.

Messrs. H. T. Brown, F.R.S., F. D. Chattaway, and R. J. Friswell, were appointed to audit the Society's accounts.

Of the following papers those marked * were read:—

*14. "Observations on the influence of the silent discharge of electricity on atmospheric air." By W. A. Shenstone and W. T. Evans.

When air is submitted to the action of the silent discharge it first contracts to a remarkable extent, and then re-expands rapidly until it very nearly occupies its original volume. The residue contains a trace of nitric peroxide. The following are some of the chief conclusions

arrived at from a study of the above phenomena. Oxygen, when diluted in nitrogen, as in the air, yields a very large proportion of ozone; 80—85 per cent. of the oxygen present may readily be ozonised in the presence of moisture, and if great care be taken as much as 98 per cent. of the oxygen may be converted into ozone.

If the ozonising of the oxygen be not pressed too far, no nitric peroxide will be formed, but at a certain stage, which probably coincides, or nearly coincides, with the point at which the amount of ozone is at its maximum, nitric peroxide is formed. In the presence of nitric peroxide, ozone is rapidly destroyed by the silent discharge, and its destruction is accompanied by a considerable destruction of nitric peroxide. The presence of water vapour promotes the formation of ozone, but retards that of nitric peroxide. It was found to be impossible to ozonise the oxygen of air in the presence of a trace of nitric peroxide.

DISCUSSION.

Dr. SCOTT asked if the diminution in the quantity of nitrogen peroxide present when all or almost all the ozone had again been decomposed might not be explained by its conversion by the moist air into nitric acid and so overlooked by the method of estimating the oxidised nitrogen which would not recognise it in this form.

Mr. SHENSTONE, in reply, said that he had not studied the effect of disruptive discharge, nor that of other diluents. In reply to Dr. ARMSTRONG, he said that the electrical conditions had been carefully regulated in the manner described in a previous communication to the Society, but all such details were now omitted, in order to economise space. In the present experiments, the difference of potential at the "spark gap" was about 13,300 volts. With regard to the question asked by Dr. Scott, of course one could not be sure that *no* nitric acid had been formed when the nitric peroxide disappeared in the presence of water, but this could hardly have occurred with the dried gas, and the behaviour of dried and damp gases seemed to correspond. Moreover, the gas was always remeasured after the ozone had been destroyed, and the amount of permanent contraction did not support the idea that the nitric peroxide had been to any considerable extent converted into nitric acid.

*15. "Some lecture experiments." By J. Tudor Cundall, B.Sc.

Conservation of Mass.—Phosphorus in a weighed and closed flask is set on fire by passing a hot wire down the hollow stem of the deflagrating spoon containing it, thus raising the temperature of the spoon to the igniting point of the phosphorus.

Graham's Law of Diffusion.—A tube is filled so that it can be filled with hydrogen and other gases, and then connected to a filter pump by means of a closed up piece of the stem of a clay pipe, through the walls of which the gas can diffuse into the partial vacuum. The times that it takes for water to rise from one mark to another when the tube is filled with different gases are noted, and it is found that these are very nearly in the same ratio as the square roots of the densities of the gases.

DISCUSSION.

Professor ARMSTRONG observed that the apparatus used for ignition of the phosphorus was needlessly complicated. All that is necessary is a glass flask in which a piece of phosphorus is ignited by heating the flask, which is then closed with a rubber stopper. In this simple form, the experiment was well known in many elementary schools throughout the country.

- *16. "Note on the preparation and properties of o-chlorbrombenzene." By J. J. Dobbie, M.A., D.Sc., and Fred Marsden, M.Sc., Ph.D.

In this paper the authors describe the preparation and properties of o-chlorbrombenzene. It is a clear straw-coloured liquid with a strong aromatic odour. It boils constantly at 204° (i V) under a pressure of 765 mm., and does not solidify at -10° . Sp. gr. at $12.5^{\circ} = 1.6555$. $\mu_D = 1.583$.

- *17. "The ultraviolet absorption spectra of some closed chain carbon compounds." By W. N. Hartley, F.R.S., and J. J. Dobbie, M.A., D.Sc.

The authors give the results of the examination of the absorption spectra of a number of organic substances differing in constitution from those previously examined by Professor Hartley and his fellow-workers. The absorption spectra of substances containing closed chains wherein four or six carbon atoms are singly linked, or two pairs are doubly linked, and of substances containing oxygen or other polyvalent atoms as links in a closed chain, were studied. The examples selected were diketohexamethylene, pyrrol, thiophene, furfurane, furfurol, pyromucic acid, and furfuramide. Tables showing measurements of the extent and intensity of the absorption by each of these substances are given. The absorption of the ultraviolet rays by solutions of some of them, and notably of thiophene, is very intense, but in no case is there any selective absorption.

The conclusion arrived at is that however intense the absorption of the ultraviolet rays may be, bodies possessing the constitution of those examined show no absorption bands.

- *18. "Note on the absorption bands in the spectrum of benzene." By W. N. Hartley, F.R.S., and J. J. Dobbie, M.A., D.Sc.

In the earliest paper on the spectrum of benzene (Hartley and Huntington), it was described as showing six absorption bands, four of which are more persistent and stronger than the other two. Owing to the want of means to obtain a continuous spectrum, some difficulty was experienced in measuring with accuracy the weaker bands. By using a wide slit, lenses of long focus and a powerful spark, the rays are sufficiently continuous, but at a sacrifice of accurate measurement of the fiducial spark lines. One feature, however, was noticeable in spectra obtained in this way: the absorption bands were all degraded in the direction of the least refrangible rays. This was considered as suggestive of the bands consisting of groups of lines stronger and closer together on the more refrangible side, weaker and wider apart on the less refrangible. By using a very powerful spark the rays emitted by cadmium electrodes may be rendered sufficiently continuous to show these bands and at the same time render the lines sufficiently sharp to measure them by, and from such a photograph taken a year ago, the absorption bands have been again measured.

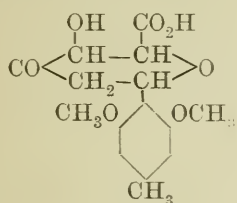
The results of the series of measurements taken from this photograph are compared with those obtained by Pauer by examining the vapour of benzene (*Wied. Ann.*, 1897, **61**, 362), and it is shown that his weak line λ 2670 is identical with the first absorption band, and his weak band λ 2390—2360 with the sixth absorption band observed in solutions of benzene in alcohol.

- *19. "A chemical examination of the constituents of Indian and American podophyllum." By Wyndham R. Dunstan, F.R.S., and T. A. Henry.

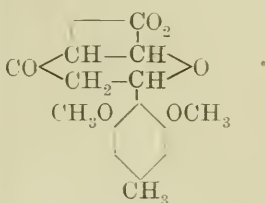
The authors find that the constituents of Indian podophyllum (*Podophyllum emodi*) and of American podophyllum (*Podophyllum peltatum*) are identical. The chief constituent is the *podophyllotoxin* of Podwysoski and Kürsten which the authors have fully examined. It is a neutral crystalline substance (m. p. 117°), to which the authors assign the formula $C_{15}H_{14}O_6$. It is strongly laevorotatory, and acts as a powerful purgative and intestinal irritant. When heated with alkalis, it is converted by hydration into the salt of an unstable, gelatinous acid, *podophyllic acid*, $C_{15}H_{16}O_7$, of which a crystalline sodium salt was obtained, and also silver and copper salts, which were analysed. This acid very readily loses water, and furnishes the crystalline *picropodophyllin* of Podwysoski and Kürsten, which is isomeric

with podophyllotoxin. It passes again into podophyllic acid when warmed with aqueous alkalis. It melts at 227° , and is optically inactive. Podophyllotoxin and pieropodophyllin furnish identical decomposition products; when oxidised with nitric acid, *oxalic acid* is the principal product; when fused with alkalis, *oreinol* and *acetic acid* are produced. Both substances contain two methoxyl groups and no hydroxyl. It is concluded that pieropodophyllin is the lactone of podophyllic acid, which is probably the hydroxy-carboxylic acid of *dimethoxymethyl-phenylhydro- γ -pyrone*.

The following formulæ are assigned to these compounds :



Podophyllic acid.



Pieropodophyllin.

The nature of the isomerism of podophyllotoxin and pieropodophyllin remains to be determined. The latter substance is therapeutically inert.

The yellow colouring matter of podophyllum, called by Podwysozki podophylloquercetin, is proved by the authors to be identical with *quercetin*, the valuable yellow colouring matter of quercitron bark.

An uncrystallisable resin, *podophylloresin*, was also isolated and found to exert a purgative action.

Estimations have been made of the amount of "podophyllin" (a mixture of resins with podophyllotoxin which is used in medicine) contained in the two plants. Indian podophyllum contains from 9 to 12 per cent., and American from 4 to 5 per cent. The two resins have been proved to be equally valuable therapeutic agents. The amount of crystalline podophyllotoxin in the Indian plant varies from 2 to 5 per cent., whilst representative samples of the American rhizome were found to contain rather less than 1 per cent.

Indian podophyllum is likely to be valuable both as a drug and as a dye-stuff.

DISCUSSION.

Mr. E. J. MILLARD asked if Professor Dunstan had noticed and could account for the smaller solubility of the resin from *P. emodi*. This was specially marked in the presence of a small quantity of an alkali when it assumed a gelatinous consistency. Since attention had been drawn to this resin by Professor Dunstan, manufacturers had prepared it in considerable quantities and it was known commercially as the less soluble variety.

Professor DUNSTAN said, in reply, that any difference that may be observed in the solubility and other properties of podophyllin resin prepared from Indian podophyllum and that prepared from American podophyllum was probably accounted for by the different proportions in which the constituents were mixed in the resins prepared from the two sources and not by any difference in the constituents themselves.

***20. "The volatile constituents of the wood of *Goupia tomentosa*."**
By Wyndham R. Dunstan, F.R.S., and T. A. Henry.

Goupia tomentosa is a large tree growing in British Guiana, where it is known as 'kabucalli.' The wood is hard, and is used in the colony for boat-building. When freshly cut it emits a smell resembling that of valerian. By distilling the wood with water, a mixture of acids of the acetic series was obtained, from which the authors have isolated and identified *formic acid*, *isovaleric acid*, *normal caproic acid* and *lauric acid*. A small quantity of *succinic acid* was also obtained.

***21. "On oxycannabin from Indian hemp."** By Wyndham R. Dunstan, F.R.S., and T. A. Henry.

Oxycannabin is the name given by Bolas and Francis to a crystalline substance they obtained by acting on the pharmacopœial extract of Indian hemp with concentrated nitric acid (*Trans.*, 1869, 22, 417; *Chem. News*, 1871, 24, 77). They obtained it in the form of yellow needles melting at 176° , and represented its composition by the formula $C_{20}H_{20}N_2O_7$. In the course of the examination of the constituents of Indian hemp, the authors have prepared the substance in this way, and have also obtained it by the action of fuming nitric acid on the "cannabinol" isolated by Messrs. Wood, Spivey and Easterfield (*Trans.*, 1896, 69, 544) from the "charas" or resin of Indian hemp.

When quite pure, oxycannabin crystallises in colourless needles melting at 182° ; it is insoluble in water, but soluble in hot alcohol, crystallising out on cooling. It sublimes when gently heated, and may be easily purified in this way. On combustion, the substance gives numbers agreeing with those required by the formula $C_{10}H_{10}NO_4$.

It does not dissolve in aqueous alkalis unless warmed with them in a closed tube. By acidifying the resulting solution, an acid is precipitated which is at present under investigation. "Oxycannabin" would therefore appear to be a lactone.

On reduction with hydriodic acid, or with tin and hydrochloric acid, oxycannabin furnishes a volatile amine. The hydrochloride of this base, though itself unstable, gives a well-crystallised platinichloride.

When heated with zinc dust, oxycannabin gives off a large amount of an inflammable gas (probably methane), and a quantity of an aromatic hydrocarbon is produced, which forms a well-crystallised compound with picric acid.

By the action of nitric acid on cannabinol, *normal butyric acid* was also produced, together with *oxalic acid*.

As the substance is thus proved to be a nitro-compound, the name "oxycannabin" is inappropriate, but it would be premature to propose a new name until more is known about the constitution of the compound.

In the course of purifying cannabinol through the acetyl derivative mentioned by Messrs. Wood, Spivey and Easterfield, the acetyl derivative was obtained in colourless crystals melting at 75° , which corresponded in composition to the formula $C_{18}H_{23}AcO$.

DISCUSSION.

The PRESIDENT remarked that a similar investigation of the products of "oxycannabin" had been carried on for some time in the University Laboratory at Cambridge by Messrs. Spivey and Easterfield, and that they had isolated substantially the same products.

22. "On the condensation of formaldehyde with ethylic malonate, and on cis- and trans-tetramethylenedicarboxylic acids (1:3)."

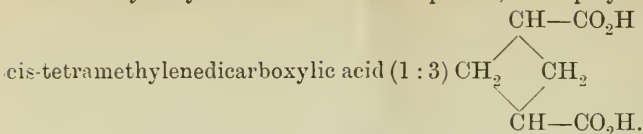
By E. W. Haworth and W. H. Perkin, jun.

In a paper published some time since (*Ber.*, 1886, 19, 1053), it was shown that when formaldehyde condenses with ethylic malonate in the presence of acetic anhydride, the principal product of the reaction is ethylic propanetetracarboxylate, $(CO_2Et)_2CH \cdot CH_2 \cdot CH(CO_2Et)_2$, but that at the same time a substance boiling at $208-212^{\circ}$ is produced in small quantities, which, from the results of the analysis, was thought at the time to be ethylic methylenemalonate, $CH_2:C(CO_2Et)_2$.

In further investigating this reaction with large quantities of material, these results have been confirmed. The condensation product contains the following substances.

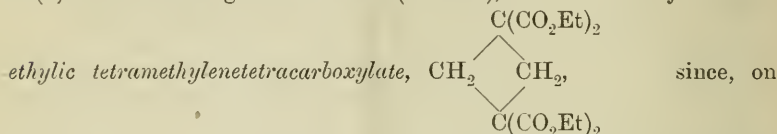
(1). *Ethylic methylenemalonate*, $CH_2:C(CO_2Et)_2$, distils at 208° as a colourless oil which, on standing, rapidly polymerises into a hard, wax-like substance, which is sometimes transparent and sometimes opaque. The polymeride, which is probably identical with the substance obtained by Zelinsky (*Ber.*, 1889, 22, 3294) by the action of methylene iodide on ethylic malonate, on distillation, yields small quantities of ethylic methylenemalonate, and considerable quantities of high-boiling oils which are at present under investigation.

When hydrolysed with alcoholic potash, the polymeride yields



(2). An oil boiling at 234—236° (80 mm.). Ethylic propanetetracarboxylate, $(\text{CO}_2\text{Et})_2\text{CH}\cdot\text{CH}_2\cdot\text{CH}(\text{CO}_2\text{Et})_2$.

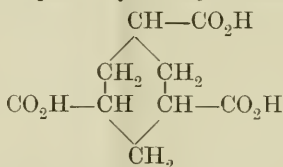
(3). An oil boiling at 250—300° (40 mm.), which evidently contains



hydrolysis, an acid is obtained which, after elimination of carbon dioxide and etherification, yields *ethylic cis-tetramethylenedicarboxylate* (1 : 3) (b. p. 172° at 50 mm.). This ethereal salt, on hydrolysis, yields pure cis-tetramethylenedicarboxylic acid melting at 131°.

(4). When the fraction 250—300° (40 mm.) is treated as above, it yields besides ethylic cis-tetramethylenedicarboxylate, an ethereal salt boiling constantly at 202° (30 mm.), and from this, on hydrolysis, a crystalline acid is obtained melting at 114°.

This acid, which on analysis gives numbers agreeing well with the formula $\text{C}_9\text{H}_{12}\text{O}_6\cdot\text{H}_2\text{O}$, is probably *hexahydrotrimesic acid*,



and in order to determine whether this view is correct, the acids formed by reducing trimesic acid are being investigated. The authors have already succeeded in preparing a crystalline tetrahydrotrimesic acid, $\text{C}_6\text{H}_7(\text{CO}_2\text{H})_3$, which melts at about 185°, and is characterised by being very sparingly soluble in ether, but excessively soluble in water.

During the course of this research, Markownikoff's work on the action of dry sodium ethylate on ethylic α -chloropropionate has been carefully repeated (*Journ. Russ. Chem. Soc.*, 1890, 22, 285; *Ann.*, 1881, 208, 333). It is found that both the cis- and trans-modifications of tetramethylenedicarboxylic acid (1 : 3) are formed in this way, and not only the trans-modification as Markownikoff states. The trans-acid (m. p. 171°), on treatment with acetylchloride, yields the anhydride of the cis-acid (m. p. 50—51°), and this, on treatment with water, is readily converted into the cis-acid (m. p. 131°).

It is remarkable that Markownikoff, who first observed this be-

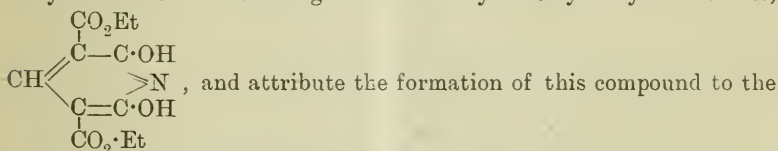
haviour, should have assumed that the *trans*-tetramethylenedicarboxylic acid, during this series of reactions, undergoes molecular change, and that the anhydride melting at 50—51° is the anhydride of tetramethylenedicarboxylic acid (1 : 2), *i.e.*, $\begin{array}{c} \text{CH}_2-\text{CH}-\text{CO} \\ | \quad | \\ \text{CH}_2-\text{CH}-\text{CO} \end{array} > \text{O}$.

It will be shown in the detailed description of the experiments that Markownikoff's view, which has caused a good deal of confusion in the chemistry of the tetramethylenedicarboxylic acids, is certainly incorrect.

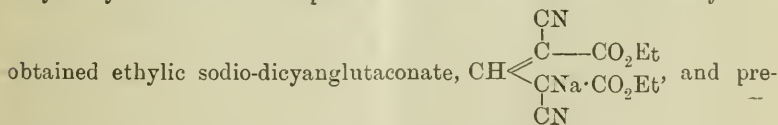
The authors are also engaged in investigating the action of methylene iodide on the disodium derivative of ethylic propanetetracarboxylate, and hope to be able soon to communicate the results of their experiments to the Society.

23. "Formation of ethylic dihydroxydinicotinate from ethylic cyanacetate." By S. Ruhemann, Ph.D., M.A., and K. C. Browning, B.A.

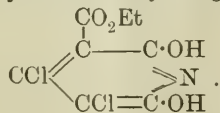
The authors give an account of their examination of the mother liquor from the preparation of ethylic sodio-dicarboxyglutaconate. They succeeded in isolating from it ethylic dihydroxydinicotinate,



presence of ethylic cyanacetate in the ethylic malonate. In order to verify this explanation, they studied the action of chloroform on ethylic cyanacetate in the presence of sodium alcoholate. They thus



pared from it other metallic compounds and the ethereal salt itself (compare Errera, *Gaz. chim. Ital.*, 1897, 27, 393). On boiling the ethereal salt with dilute hydrochloric acid, ethylic dihydroxydinicotinate (m. p. 202°) is formed. Chlorine transforms the pyridine-derivative into ethylic dichloridihydroxynicotinate, to which, from its behaviour towards phenylhydrazine, they assign the formula



At the next meeting, on Thursday, March 3rd, the following papers will be communicated by the authors.

“Note on the preparation of dry hydrogen cyanide and carbon monoxide.” By John Wade, B.Sc., and Laurence C. Panting, M.B., B.Ch.

“Production of nitro- and amido-oxylutidines.” By Professor J. N. Collie, Ph.D., F.R.S., and T. Tickle.

“Production of some nitro- and amido-oxylutidines. Part II.” By Professor J. N. Collie, Ph.D., F.R.S., and Miss L. Hall.

“On benzene hexabromide.” By F. E. Matthews, Ph.D.

“Note on manganic salts.” By C. E. Rice, B.A.

“Some chemical properties of concentrated solutions of certain salts.” Part I. Potassium carbonate.” By W. C. Reynolds.

PROCEEDINGS
OF THE
CHEMICAL SOCIETY.
EDITED BY THE SECRETARIES.

No. 190.

Session 1897-8.

March 3rd, 1898. Professor Dewar, F.R.S., President, in the Chair.

Mr. Cecil J. Brooks was formally admitted a Fellow of the Society.

Certificates were read for the first time in favour of Messrs. Joseph Brierley B.Sc., Ashton Road, Failsworth, Manchester; Arthur William Cowburn, Fernroyd, Bowdon, Cheshire; Charles Benjamin Dudley, Ph.D., Attoona, Penn., U.S.A.; Arthur Leonard Harry Garside, c/o C. Lawes and Co., Barking Creek; Lawrence Hislop, Gasworks, Uddingston; F. Hurter, Ph.D., Holly Lodge, Cressington Park, Liverpool; Samuel Morton Jessop, 12 Hanson Terrace, Wakefield; George Henry Masson, M.D., M.S., 22 Lauriston Place, Edinburgh; Walter Charles Cross Paters, 14 Trinity Square, S.E.; Francis Pitt Smith, B.Ph., 77 Woodland Avenue, New Rochelle, N.Y., U.S.A.; Thomas de Smith, B.A. Eastbourne College, Eastbourne; William Thomas Newton Spivey, M.A., 5 Trumpington Street, Cambridge; John Alexander Williamson, 81 Cheverton Road, Upper Holloway, N; Thomas Barlow Wood, M.A., Caius College, Cambridge.

Of the following papers those marked * were read :—

- *24. "Preparation of anhydrous hydrogen cyanide and carbon monoxide." By John Wade, B.Sc., and Laurence C. Panting, M.B.

On allowing a cold mixture of equal volumes of sulphuric acid and water to drop on to 98 per cent. "lump" potassium cyanide, hydrogen cyanide, accompanied by traces of water only, is evolved in almost theoretical amount, and with the aid of suitable condensing apparatus is readily collected in quantity. With concentrated sulphuric acid, on

the other hand, but still at the ordinary temperature, nearly pure carbon monoxide is evolved, also in quantity approaching the theoretical; provided certain precautions are taken, it is free from dioxide, and is accompanied only by small quantities of hydrogen cyanide.

In discussing the mechanism of the formation of the monoxide, experiments are described showing that part of the water required for the hydrolysis is derived either from the sulphuric acid itself or from the potassium hydrogen sulphate formed in the course of the action, and that consequently the sulphuric acid acts at the same instant both as a hydrolyst and as a dehydrating agent.

***25. "Production of some nitro- and amido-oxylutidines." By J. N. Collie, Ph.D., F.R.S., and Thomas Tickle.**

In a former paper (*Trans.*, 1897, 71, 838) one of the authors drew attention to the fact that various nitro- and amido-derivatives of pyridine could be obtained by the ordinary process of nitration and reduction of certain oxypyridine compounds. These substances correspond in the pyridine series to nitro- and amido-phenols in the benzene series, and as some of the reactions (especially those with various oxidising agents) of the amido-oxypyridines resemble those of alkaloids, the investigation has been continued.

Pseudolutidostyryl ($\alpha\gamma$ -dimethyl- α' -oxypyridine) gave on nitration a *nitropseudolutidostyryl*, $C_5H_4NMe_2(OH)NO_2$. It crystallises in light yellow needles that melt with much decomposition at about 250° . The hydroxyl and nitro-groups are in the ortho-position to one another, but the substance is not volatile with steam. With alkalis, it forms brilliant, yellow compounds.

When the nitro-compound is reduced with tin and hydrochloric acid, an amidopseudolutidostyryl is produced. The hydrochloride of this base, $C_5H_4NMe_2(OH)NH_2HCl$, crystallises in needles which decompose without melting at $235-240^\circ$. By the action of sodium bicarbonate, the free base can be obtained in the form of a bulky mass of fine needles, m. p. 205° (corr.). The base is very soluble in hot water, but much less so in cold. It oxidises readily, and an aqueous solution on boiling turns brown. This solution reduces silver nitrate at once. With ferric chloride, it gives first a red and then a bright green colour, and when dissolved in strong sulphuric acid, if a drop of fuming nitric acid be added, a brilliant purple colour is momentarily produced. It forms a platinichloride and an acetyl derivative, m. p. 255° (corr.).

By nitrating ethylic pseudolutidostyrylcarboxylate (m. p. $137-138^\circ$) a nitro-derivative was formed, $C_5H_3NMe_2(OH)(CO_2Et)NO_2$. This substance, m. p. 215° (corr.), crystallises in yellow needles. On hydrolysis,

it yielded the corresponding acid, m. p. 260° (corr.), which when pure is almost colourless, but forms bright yellow salts. The acid on heating loses carbon dioxide and the same nitro-pseudolutidostyryl (m. p. about 250°) was obtained.

Amido-pseudolutidostyrylcarboxylic acid was prepared from the corresponding nitro-acid by reduction. Its hydrochloride crystallises from water in needles with 2 molecules of water. The amido-acid melts at 275° (corr.), and contains 1 molecule of water of crystallisation; above its melting point it decomposes, yielding amido-pseudolutidostyryl (m. p. 205° corr.). Its salts reduce silver nitrate solution, and with ferric chloride give a green coloration.

***26. "Production of some nitro- and amido-oxylutidines. Part II."**
By Miss L. Hall and J. Norman Collie, Ph.D., F.R.S.

Lutidone, *aa'*-dimethyl- γ -oxypyridine, when warmed with nitric acid, does not yield a nitro-derivative (*Trans.*, 1897, 71, 838), but a nitrate of lutidone. If, however, a mixture of strong nitric and sulphuric acids are employed, the nitro-compound is formed, $C_7H_9NO + HNO_3 = C_7H_8NO \cdot NO_2 + H_2O$. This nitrolutidone is a pale yellow, crystalline compound, possessing a strong acid reaction, and dissolving in alkalis with an intense yellow colour; it is not volatile in steam. When reduced with tin and hydrochloric acid, it yields an amido-lutidone, $C_7H_8NO \cdot NO_2 + 3H_2 = C_7H_8NONH_2 + 2H_2O$. This amidolutidone, unlike amidodioxypicoline and amidopseudolutidostyryl, does not give characteristic colours with oxidising agents, but acts as a strong reducing agent. It forms both a monohydrochloride and a dihydrochloride. The platinichloride is unstable; it undergoes reduction when dissolved in water and warmed, but if its hydrochloric acid solution is boiled, a very insoluble platinichloride separates, which seems to be the salt of propine diamine, $\begin{array}{c} Me \cdot C \cdot NH_2 \\ | \\ HC \cdot NH_2 \end{array} 2HCl \cdot PtCl_4$, the decomposition having been brought about by hydrolysis, $C_7H_{10}N_2O + 3H_2O = C_3H_5N_2 + 2C_2H_4O_2$. This breaking down of the pyridine ring is of considerable interest, and, in a substance like lutidone, is hardly to be expected, since the nitrogen atom is bound to two carbon atoms, neither of which are united to oxygen, and, moreover, lutidone is not the anhydride of an amido-acid.

DISCUSSION.

Mr. LING pointed out that certain anilides give, when treated with oxidising agents in acid solution, colour reactions similar to those obtained with alkaloids (*Tafel, Ber.*, 1892, 25, 412; Schär, *Archiv Pharm.*, 1894, 232, 249).

Prof. COLLIE, in reply to suggestions of Dr. WYNNE, pointed out that it was impossible in the case of lutidone to obtain more than one mono-nitro-derivative. In nitrating pseudolutidostyryl, the position of the entering nitro-group had been determined with certainty by the fact that pseudolutidostyrylcarboxylic acid, after nitration and subsequent heating, yielded the same nitro-compound as had been obtained from pseudolutidostyryl itself.

***27. "On benzene hexabromide." By F. E. Matthews, Ph.D.**

In this paper, the author describes his failure to isolate the second modification of benzene-hexabromide, obtained, in minute quantity, by Orndorf and Howells (*Amer. Chem. Journ.*, 1896, 18, 312—319) even from considerable quantities of the crude hexabromide; also the failure to prepare either the hexachloride or hexabromide of bromobenzene; in the former case owing to the displacement of chlorine by bromine, and in the latter to the substitution of bromine taking place more readily than direct addition.

The action of alcoholic soda upon benzene hexabromide is also described, the product of the action being a mixture of paradibromo- and tribromobenzene (1 : 2 : 4), possibly mixed with a small amount of one of the other dibromobenzenes. Benzene obtained from the hexabromide by nascent hydrogen in acid alcoholic solution yields both modifications of the hexachloride on treatment with chlorine.

DISCUSSION.

Professor TILDEN was glad that Dr. Matthews had resumed work on these interesting compounds. He had repeated some of Dr. Matthews' experiments, and had satisfied himself that the hexachloride was obtainable very readily and in very large proportion. It was somewhat remarkable that the corresponding bromide should be formed so much less readily.

Dr. MATTHEWS stated that he had always worked with material spontaneously precipitated from the mixture of benzene, bromine, and water, and not with the substance left after evaporating the mixture to dryness, as was the case with Orndorf and Howells.

***28. "Note on the action of bromine on benzene." By J. Norman Collie, Ph.D., F.R.S., and Colin C. Frye.**

The authors have repeated the work of Ador and Rilliet (*Ber.*, 1875, 8, 1286) who stated that when bromine was allowed to act on excess of benzene in sunlight, dibromo-addition products were produced, which, after treatment with zinc ethyl and subsequent oxidation with chromic

acid, yielded metabromo- and metaphthalic acids, together with benzoic acid, parabromobenzoic, and terephthalic acid, but they were unable to obtain any ortho-compounds. The authors have succeeded in proving the presence of ortho-compounds, and at the same time have confirmed the observations of Ador and Rilliet, having isolated para-bromobenzoic acid and metaphthalic acid.

DISCUSSION.

Dr. MATTHEWS said that he had made several attempts to isolate di- and tetra-chlorine and bromine addition-compounds of benzene, both by the action of the halogens upon excess of benzene and also by decomposition of the hexabromide and hexachlorides of benzene, but always without finding a trace of any di- or tetra-halogen addition-derivative.

*29. "Note on manganic salts." By C. E. Rice, B.A.

The author shows that the decomposition of manganic chloride in solution into manganous chloride and chlorine is reversible, the velocity of the reverse change being very small. He also describes the production and analysis of two double manganic chlorides, $2\text{KCl} \cdot \text{MnCl}_3 \cdot \text{H}_2\text{O}$ and $2\text{NH}_4\text{Cl} \cdot \text{MnCl}_3 \cdot \text{H}_2\text{O}$, but obtains no evidence of the existence of any compound of the formula MnCl_4 .

DISCUSSION.

Professor CLOWES asked which of the manganese hydroxides was precipitated by the action of water upon the crystalline hydrated double chloride; it would be interesting to know whether a hydroxide corresponding to the formula MnCl_3 could exist.

Professor TILDEN remarked that the manganese tetrachloride seemed to be now finally disposed of, and in representing the production of chlorine by the usual process we should have to write a new equation.

Mr. RICE, in reply, said that he had not considered it necessary to investigate the point, since Pickering had shown that when the solution obtained by dissolving any of the higher oxides of manganese (Mn_2O_3 , Mn_3O_4 , MnO_2) in hydrochloric acid is diluted, the precipitate consists of a mixture of these hydrated oxides in varying proportions.

*30. "Some chemical properties of concentrated solutions of certain salts. Part I. Potassium carbonate." By W. Colebrook Reynolds.

When the salts of certain other metals are added to a concentrated solution of potassium carbonate, double salts are formed which are sometimes, as in the cases of iron, copper, nickel, and cobalt, soluble in the

solution, instead of the normal or basic carbonates which are formed when a dilute solution is employed.

These double salts and their solutions are decomposed by pure water. To obtain them, the chloride, nitrate, or preferably the acetate, is added to a concentrated solution of potassium carbonate (sp. gr. 1.55), and the liquid left to crystallise. The author has isolated the following double salts in well defined crystalline form:—
 $\text{CuK}_2(\text{CO}_3)_2$, $\text{CuK}_2(\text{CO}_3)_2 \cdot \text{H}_2\text{O}$, $\text{CuK}_2(\text{CO}_3)_2 \cdot 4\text{H}_2\text{O}$, $\text{MnK}_2(\text{CO}_3)_2 \cdot 4\text{H}_2\text{O}$,
 $\text{FeK}_2(\text{CO}_3)_2 \cdot 4\text{H}_2\text{O}$, $\text{CaK}_2(\text{CO}_3)_2$, $\text{Bi}_2\text{OK}_4(\text{CO}_3)_4 \cdot \text{H}_2\text{O}$, $\text{CoK}_2(\text{CO}_3)_2 \cdot 4\text{H}_2\text{O}$,
 $\text{NiK}_2(\text{CO}_3)_2 \cdot 4\text{H}_2\text{O}$, $\text{MgK}_2(\text{CO}_3)_2 \cdot 4\text{H}_2\text{O}$, AgKCO_3 . The last four salts have been previously obtained by other chemists.

DISCUSSION.

Professor TILDEN said that Mr. Reynolds had been led to the study of these compounds in the course of enquiring into the production of the recently discovered percarbonates. In dilute solution, potassium carbonate appeared to be resolvable into the ions 2K and CO_3 , while in a saturated solution it behaved as though made up of K and KCO_3 . Mr. Reynolds had omitted to point out that in the formulæ of all his new double carbonates, the heavy metal seemed to be associated with a proportion of KCO_3 corresponding to its valency. Perhaps this was only a coincidence, but it seemed to deserve notice.

Mr. A. G. BLOXAM remarked that if carbonic acid was regarded as a hydroxy-acid the formation of a deep blue coloured solution by mixing a concentrated solution of potassium carbonate with a solution of copper sulphate became of interest as bringing carbonic acid into line with other hydroxy-acids, all, or nearly all, of which were known to give deep blue coloured solutions with copper sulphate and alkali sufficient to satisfy both the acidic and phenolic or alcoholic hydroxyl groups. Such solutions, however, were more stable than the potassium copper carbonate solution of Mr. Reynolds, and this might be due to a comparatively unstable condition of potassium carbonate in solution; if a strong solution of this salt was partly decomposed on dilution, potassium hydroxide and bicarbonate being formed, a corresponding decomposition of the copper compound would be expected. He would be glad to learn from Mr. Reynolds whether addition of potassium hydroxide hindered the precipitation of copper carbonate on dilution.

Mr. W. P. BLOXAM asked whether the formation of these salts was attended with the evolution of carbon dioxide. Had the author taken into account the hydrolysis of potassium carbonate which took place in aqueous solution? According to a paper published by Senderens, the action of a non-metallic element (sulphur) upon solution of potassium carbonate could be explained by regarding the salt as hydrolysed thus, $\text{H}_2\text{O} + \text{K}_2\text{CO}_3 = \text{KHCO}_3 + \text{KOH}$; and experiments made by the

speaker showed that even a concentrated solution of the salt must be regarded as possessing this constitution. The presence of more oxygen in the double carbonate of bismuth than that present in the acid groups would be explained by the action of the hydroxide groups present in the carbonate solution. The same reaction would also explain the difficulty of obtaining manganous and ferrous double carbonates.

Mr. REYNOLDS, in reply, stated that it was possible to represent the formation of these compounds as taking place in accordance with such an equation as, for instance, $\text{MnCl}_2 + 2\text{K} \cdot \text{KCO}_3 = \text{Mn}(\text{KCO}_3)_2 + 2\text{KCl}$, and this view was strengthened by the fact that some of the salts, as, for instance, copper acetate, dissolved immediately without forming a precipitate which subsequently redissolved.

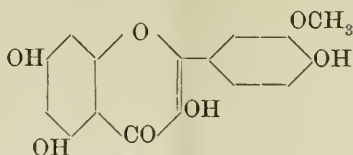
In the case of the double succinates, however, where exactly the same phenomena occurred, the composition of the copper compound was $\text{CuK}_4(\text{C}_4\text{H}_4\text{O}_4)_3 \cdot 2\text{H}_2\text{O}$, and this could not be represented by a similar equation. He had, therefore, not introduced such views into the present paper, as they did not appear to be generally applicable.

The author did not think that any of the phenomena supported the view that the solution contained potassium hydroxide and potassium bicarbonate, as no effervescence occurred, except in the case of normal bismuth salts, when basic salts were formed.

31. "The colouring matters of the Indian dyestuff *Delphinium zalil*." By A. G. Perkin and J. A. Pilgrim.

"Asbarg" consists of the dried flowers and flowering stems of the *Delphinium zalil*, found in great quantity in Afghanistan, and which is much used in India for the production of a yellow colour on alum mordanted fabrics. The flowering stems are nearly devoid of dyeing property. For the supply of material we are indebted to the authorities of the Imperial Institute. Three colouring matters exist in this plant in the form of glucosides. The sparingly soluble colouring matter, $\text{C}_{16}\text{H}_{12}\text{O}_7$, forms glistening yellow needles, soluble in alkalis with a yellow colour. Fused with alkali it yielded phloroglucinol and protocathechuic acid, and by means of hydriodic acid it yielded quercetin with the evolution of 1 mol. of methylic iodide. By methylation it was converted into quercetintetramethyl ether, and by acetylation into a tetracetyl derivative of the formula $\text{C}_{16}\text{H}_8\text{O}_7(\text{C}_2\text{H}_3\text{O})_4$, colourless needles, m. p. 195—196°. It was evidently *isorhamnetin*, a quercetinmonomethyl ether, recently isolated from the yellow wallflower, *Cheiranthus Cheiri* (Trans., 1896, 69, 1650). As by oxidation in

alkaline solution this yields vanillic acid, it has most probably the constitution represented by this formula.



With alumina as mordant it dyes a purer yellow than quercetin. The chief constituent of the more soluble portion was recognised to be identical with *quercetin*, the colouring matter of quercitron bark. The residual colouring matter, present only in small quantity, was not obtained in a pure condition. It resembled quercetin in percentage composition, and in its decomposition products, but differed from it in not reacting with alcoholic potassium acetate, and the melting point of its acetyl derivative. "*Asbarg*" resembles quercitron bark in dyeing property, but has only 35 per cent. the tinctorial power of this dyestuff. It contains, when freed from the flowering stalks, 3.47 per cent. of colouring matter (not as glucoside).

32. "Some metallic salts of natural yellow colouring matters."

By A. G. Perkin and P. J. Wood.

That certain colouring matters decompose alkaline carbonates with the formation of acid salts has been previously demonstrated. Thus of morin, Hlasiwetz and Pfaundler describe salts of this description, and of quercetin (*Jahresbericht*, 1864, 560). Further, from gentisin, Hlasiwetz and Habermann (*A.* 1875, 175, 73) obtained analogous compounds. Among other instances is bixin, the colouring matter of Annatto, which Etti describes (*Ber.*, 1878, 11, 864) as giving a sodium and a potassium salt, and rottlerin, from which one of us obtained similar compounds (*Trans.*, 1895, 67, 230).

Owing probably to the formation of acid salts these alcoholic alkaline solutions are not readily neutralised completely by acetic acid, and as it appeared that some of the formulæ of the above compounds must be incorrect, this reaction was studied. It was found that in alcoholic solution, quercetin, morin, fisetin, and myricetin decompose potassium and sodium acetates with the formation of sparingly soluble salts. *Potassium quercetin*, $C_{15}H_9O_7 \cdot K$ (Found $K = 11.46$. Theory requires $K = 11.47$), forms minute orange-yellow prismatic needles, insoluble in cold water and but slowly decomposed by boiling dilute acetic acid. *Sodium quercetin*, $C_{15}H_9O_7 \cdot Na$, closely resembles the above salt. *Potassium morin*, $C_{15}H_9O_7 \cdot K$ (Found $K = 11.97$. Theory requires $K = 11.47$), separates as glistening, orange-coloured needles, and is closely resem-

bled by *sodium morin*, $C_{15}H_9O_7Na$ (Found $Na = 6.89$. Theory 7.09). Morin reacts with magnesium and ammonium acetates, though from quercetin salts have not been obtained in this way. *Ammonium morin* and *magnesium morin* separate in the form of long needles in a similar way (Found $Mg = 3.52$. Theory requires $Mg = 3.83$ per cent.).

Fisetin and myricetin apparently yield analogous derivatives, and on the other hand luteolin, apigenin, chrysin, and gentisin do not appear to react with alkaline acetates. With the exception of bixin and rottlerin, as yet but little examined, the above colouring matters are known to contain no carboxyl group, and it is thus of interest to study this reaction in which only one of the numerous hydroxyls present takes part. It appears probable that some analogy exists between these salts and the acid compounds of the colouring matters described by one of us (Trans., 1896, 69, 1439).

33. "The interaction of magnesium and solution of copper sulphate."

By Edward Divers, M.D., F.R.S.

Neither Clowes and Caven nor Tilden, in their communications made to the Society in November last, seem to the writer to have recognised the significance of the results of the interaction of magnesium metal and a solution of copper sulphate. Remarkable as these results are, it is to be remembered that a closely analogous case had long been known, even when Commaille in 1866 observed them, namely, that of zinc immersed in a solution of an alum. Here, also, there is free evolution of hydrogen and precipitation of basic sulphate, and, when chromium alum replaces the aluminium salt, there is also reduction of some of the chromic sulphate to chromous sulphate. The only part of the change which finds no parallel in the action of zinc upon chrome alum is that of the deposition of a little copper, but this deposition is quite in accordance with the general behaviour of copper salts.

The formation of basic salt and hydrogen is a change independent of that of reduction, as is clearly shown by the same formation taking place, without that of reduction, when aluminium sulphate or common alum is concerned. Now, since the alum solution is dialysable into sulphuric acid and basic aluminium or chromium sulphate (besides potassium sulphate), and is also strongly acid in reaction, it will be admitted by all that the action in the case of an alum is really that of dilute sulphuric acid upon the zinc. The gradual precipitation of the previously soluble basic salt as the zinc dissolves in the solution is just what happens when zinc sulphate is dissolved in a dialysed solution of aluminium, or chromium hydroxide, or basic sulphate. These two points being admitted, it will be very difficult to doubt that

similar changes occur between copper sulphate and magnesium, or, in a less degree, zinc; for the solution is here also very acid in reaction and needs only a little boiling to make it deposit basic sulphate; besides, too, it will unquestionably show largely that hydrolysing action upon cane-sugar which Long (*J. Amer. Chem. Soc.*, 1896, 18, 120) has recently shown so many metallic salts possess, and this property is evidence that, like aluminium sulphate, it is partly hydrolysed into sulphuric acid and soluble basic sulphate, which will be precipitated as magnesium goes into the solution. Caven and Clowes have pointed out the inadequacy of the action of the magnesium-copper couple to account for the large evolution of hydrogen. Their unsupported suggestion that the hydrogen is formed by the combined action of copper sulphate (as such) and magnesium upon water, has likewise little claim to consideration in presence of the fact that (hydrolysed) aluminium sulphate acts in the same way as copper sulphate.

Coming now to the production of cuprous oxide, a separate reaction, or set of reactions, there would be nothing in this unlike that of the reduction of ferric or chromic sulphate by zinc or magnesium, could cuprous salt only be found in solution. When, in place of the sulphate, cupric chloride is used, then, as every one knows, there is just this looked-for reduction to cuprous salt. But the peculiarity of copper is that oxylic cuprous salts are apparently unable to exist. It is, however, not so improbable that in dilute solution and in presence of much cupric sulphate a little cuprous sulphate may exist for a very short time. According, indeed, to Rose, from roasted copper sulphide water extracts, along with cupric sulphate, a little cuprous sulphate, which then gradually decomposes into metal and cupric salt, just as a mercurous salt in water will change into metal and mercuric salt (*Annalen*, 1841, 39, 109). However that may be, and the observation admits of another interpretation, it does seem to the writer that the precipitation of cuprous oxide during the action of magnesium upon cuprous sulphate is a fact highly favourable to the view that cuprous sulphate is actually formed, part of it then quickly decomposing into cupric sulphate and metallic copper, and the rest of it being decomposed by the basic cupric salt into normal cupric sulphate and cuprous oxide. With certainty he can state that, when finely divided copper is acted upon by nitrogen peroxide, nitric oxide and a copper nitrate are formed, and no nitrite, and that this copper nitrate, when touched with water, decomposes into cupric nitrate and bright metallic copper, thus proving, apparently, that in absence of water cuprous nitrate can exist, and, therefore, by analogy, other oxylic cuprous salts.

There remains only to notice Tilden's suggestion that some of the hydrogen reduces cupric to cuprous oxide. Hydrogen is known not to have such an action, and therefore the usual assumption of there

being a more active 'nascent' hydrogen has to be made, but also without the least foundation in experience. In the present case, it may be pointed out, firstly, that in the reduction of chromic sulphate to chromous sulphate by zinc, hydrogen continues to be evolved, although very great excess of chromic salt is always in contact with the zinc; and, secondly, that in the reduction of ferric salts by zinc it has been established that this takes place much more rapidly when clean zinc dust is put into the ferric solution in the absence of excess of acid, than when, as is usual, an excess of acid is added to generate hydrogen. It may, therefore, with great probability be assumed that the reactions are $2\text{CuSO}_4 + \text{Mg} = \text{Cu}_2\text{SO}_4 + \text{MgSO}_4$ and $\text{Fe}_2(\text{SO}_4)_3 + \text{Zn} = 2\text{FeSO}_4 + \text{ZnSO}_4$, hydrogen having nothing to do in the matter.

ADDITIONS TO THE LIBRARY.

I. *By Purchase.*

Groth P. Tabellarische übersicht der Mineralien nach ihren krystallographisch-chemischen beziehungen. Vierte auflage. Pp. viii + 184. Braunschweig 1898.

Wollny, Ewald. Die zersetzung der organischen stoffe und die humusbildungen mit rücksicht auf die bodencultur. Pp. x + 479. Heidelberg 1897.

II. *Donations.*

Bailey, G. H. The Tutorial Chemistry. Part II. Metals. Pp. vi + 295. London 1898.

From the Author.

Roscoe, H. E., und Classen, A. Lehrbuch der anorganischen Chemie Zweiter band. Dritte gänzlich umgearbeitete auflage des infrüheren auflagen von Roscoe und Schorlemmer bearbeiteten werkes. Braunschweig 1897.

From Sir H. E. Roscoe.

Pamphlets.

Louis, D. A. The Iron Industry of Hungary. (Reprinted from the *Journal of the Iron and Steel Inst.* No. II., for 1897).

Sachs, E. O. What is fire protection? A study by. Pp. 37.

Fire prevention, some American opinions on. Pp. 16.

Sachs, E. O. Paris Charity Bazaar Fire. A paper by. Pp. 52.

(Publications of the British Fire Prevention Committee, Nos. 1, 2, and 3.)

Spring, W. Sur le role des composés ferriques et des matières humiques les phénomènes de la coloration des eaux et sur l'élimination

de ces substances sous l'influence de la lumière solaire. Bruxelles 1897.

Observations sur l'hydrolyse du chlorure ferrique. Leide 1897.

Sur le spectre d'absorption de quelques corps organiques incolores et ses relations avec la structure moléculaire. Bruxelles 1897.

Sur la couleur et le spectre d'absorption de quelques corps organiques. Genève 1896.

De la température à laquelle les courants de convection commencent à produire l'opacité d'une colonne d'eau d'une longueur donnée. Bruxelles 1896.

Sur la transparence des solutions des sels incolores. Genève 1896.

De l'influence du temps sur l'agglutination de la craie comprimée. Bruxelles 1895.

Sur la couleur des alcools comparée à la couleur de l'eau. Genève. 1896.

Sur le rôle des courants de convection calorifique dans le phénomène de l'illumination des eaux limpides. Genève 1896.

Sur un hydrate de trisulfure d'arsenic et sa décomposition par la compression. Bruxelles 1895.

Spring, W., et Romanoff, L. Sur la solubilité réciproque du bismuth et du plomb dans le zinc existence d'une température critique. Bruxelles 1896.

Spring W. Über die physikalischen veränderungen, die gewisse schwefelverbindungen unter dem einfluss der temperatur erleiden. Leipzig 1895.

Notice bibliographique. Bruxelles 1896.

Woods, Hugh. *Æther, its nature and place in the universe*. London 1898.

At the next meeting, on Thursday, March 17th, the following papers will be communicated.

"The reduction of bromic acid and the law of mass action." By Winifred Judson, B.Sc., and J. Wallace Walker, M.A., Ph.D

"The action of ferric chloride on the ethereal salts of ketone acids." By R. S. Morell, M.A., Ph.D., and J. M. Crofts, B.A., Ph.D.

"Note on the volatility of sulphur." By T. C. Porter.

"Action of ammonia and substituted ammonias on acetylurethane." By George Young, Ph.D., and Ernest Clark.

PROCEEDINGS
OF THE
CHEMICAL SOCIETY.
EDITED BY THE SECRETARIES.

No. 191.

Session 1897-8.

March 17th, 1898. Professor Dewar, F.R.S., President, in the Chair.

Messrs. A. J. Buller Cooper, J. Murray Crofts, R. S. Morrell, T. Cunningham Porter, F. F. Renwick, and Harold C. Sayer were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. Oscar Julian Steinhart, Ph.D., 4, Palace St. Mansions, S.W.; Samuel A. Tucker, Ph.D., Columbia University, New York; Ernest Witham, The Grammar School, Rotherham.

ANNOUNCEMENT BY THE COUNCIL.

The PRESIDENT announced that notice of the following resolutions to be proposed at the Annual General Meeting by Messrs. Hartog and Harden had been received :—

RESOLUTION I.

“That in order to carry out the suggestion of Mr. Cozens-Hardy, Q.C., communicated by the Council to the Society at the meeting held on February 17th, 1898 (*Proc.*, 1898, 14, 38) the following steps shall be taken to ascertain the wishes of the whole Society with regard to the desirability of obtaining a Supplemental Charter for the purpose of enabling Fellows to record their votes at the Annual election of the Officers and other members of the Council by proxy or post.

(1) "The following papers shall be printed and distributed to the Fellows of the Society not later than April 14th :—

(a) "THE CHEMICAL SOCIETY,
BURLINGTON HOUSE,
PICCADILLY, LONDON, W.

"DEAR SIR,—In accordance with the resolution passed at the General Meeting of the Chemical Society held on March 31st, 1898, we are instructed to request you to be good enough to—

"(i) Answer the question printed below, by writing 'Yes' or 'No' in the space marked for the purpose.

"(ii) Fold this paper with the blank side outermost, place it in the envelope 'A' provided, close the envelope, and write your signature legibly *outside*.

"(iii) Enclose the envelope 'A' in the stamped envelope 'B,' and return this by post to the Secretaries on or before May 14th next.

"We are, faithfully yours,
"(Signatures of Secretaries).

"Are you in favour of the proposal that a Supplemental Charter should be applied for to the Privy Council so as to enable Fellows to vote at the annual election of the Officers *by post or proxy*?

"(Here write 'Yes' or 'No').

(b)

"An envelope marked thus :—

"THE CHEMICAL SOCIETY. *Re* CHARTER.

A.

"Voting Paper.

"Please sign legibly here.....

(c)

"An envelope stamped with a penny stamp, and marked thus :—

B.

"*Re Application for Supplemental Charter.*

THE SECRETARIES OF THE CHEMICAL SOCIETY,
BURLINGTON HOUSE,
LONDON, W.

"(2) At the next meeting held after May 14th the envelopes shall be opened and the voting papers placed, without being unfolded, in a

balloting-box, and they shall be counted by a sufficient number of scrutators, to be appointed by the presiding officer. The signatures on the envelopes shall be at the same time checked against an official list of Fellows of the Society, and shall be preserved for a year.

RESOLUTION II.

“If a majority of the votes recorded in accordance with the method prescribed by the foregoing resolution be in favour of an application being made for a Supplementary Charter for the purpose named, the Council shall be, and are hereby instructed, without any further proceedings, to make the necessary application without delay.”

To this notice of Resolutions the following reply had been sent:—

CHEMICAL SOCIETY,

BURLINGTON HOUSE, W.

March 17th, 1898.

DEAR SIRs,—The Council have carefully considered the proposed resolutions which you have forwarded to the Secretaries, notifying them that you intend to move them at the Annual General Meeting.

We are, in the first place, to point out that the effect of passing such resolutions would be precisely the same as passing a bye-law to enable Fellows to vote by proxy or through the post on this question, and that Mr. Cozens-Hardy, Q.C., has already advised that any such bye-law would be repugnant to the Charter.

We are directed to say that this of itself would be sufficient to make the proposed resolutions out of order, but there are other grounds on which the Council are advised that such resolutions cannot be submitted to a General Meeting.

The Council are advised that in view of the opinions of Mr. Cozens-Hardy, such resolutions would not be in order, because they propose to deal with a question which is outside the scope of matters which can be decided at a General Meeting of the Society.

They are also advised that even if such resolutions were passed they would have no power to act upon them, because in considering whether the Fellows really desire the change proposed, regard must not be had only to those who are present in person at a meeting (and still less to a bare majority of Fellows voting, as you propose), but to the wishes of the whole body of the Fellows. You will remember that Mr. Cozens-Hardy thinks that an application for a Supplemental Charter would probably not be listened to unless it represented the practically unanimous view of the Fellows, and that any active opposition by even a small minority would probably be fatal.

The Council are further advised that it would be *ultra vires* to expend any part of the funds of the Society in giving effect to the proposed resolutions or in applying for a Supplemental Charter.

In these circumstances, we are directed to inform you that it would be the President's duty to refuse to put such resolutions to the meeting.

We are also to point out that it would be open to any Fellows of the Society, at their own expense, to send out the circulars referred to in the resolutions, and that if it should be found that the Fellows were practically unanimous in desiring that application should be made for a Supplemental Charter, this could be applied for by them at the like expense, and that in the event of there being no opposition Her Majesty might be pleased to direct that such expenses should eventually be paid out of the funds of the Society.

We are, dear Sirs,

Your obedient Servants,

JOHN M. THOMSON,	} <i>Honorary</i>
WYNDHAM R. DUNSTAN,	
	} <i>Secretaries.</i>

ARTHUR HARDEN, ESQ.

P. J. HARTOG, ESQ.

Of the following papers those marked * were read :—

- *34. "The reduction of bromic acid and the law of mass action." By Winifred Judson, B.Sc., and J. Wallace Walker, M.A., Ph.D.

The authors have investigated the velocity of the reduction of bromic acid by hydrobromic acid, and find that, in the presence of a large quantity of sulphuric acid, the reaction is bimolecular, whereas in the absence of sulphuric acid it is tetramolecular. The results are in agreement with the conclusions drawn by Noyes (*Zeit. Phys. Chem.*, 1896, 19, 599) from the experiments of himself and others on the reduction of bromic acid by hydriodic acid. The explanation put forward is that the stage of the reaction, which requires a measurable time for its completion, is expressed by the equation $2\text{H}^+ + \text{Br}^- + \text{BrO}_3^- = \text{HBrO} + \text{HBrO}_2$, and that the bromous and hypobromous acids are instantly decomposed by the hydrobromic acid present. A further result obtained is that the reduction of bromic acid by hydriodic acid takes place 58.5 times faster than by hydrobromic acid, and that, therefore, although the latter is produced from bromic by hydriodic acid, its presence in no way vitiates the conclusions drawn by Noyes from that reaction.

***35. "The action of ferric chloride on the ethereal salts of ketone acids." By R. S. Morrell, M.A., Ph.D., and J. M. Crofts, B.A., B.Sc.**

When anhydrous ferric chloride dissolved in absolute ether is added to an ethereal solution of ethylic ketophenylparaconate, a red oil separates. This, when washed with absolute ether, becomes solid, and is, most probably, represented by the formula, $\text{FeCl}_2(\text{C}_{13}\text{H}_{11}\text{O}_5)$. Water decomposes the compound with formation of the basic ferric salt of ethylic ketophenylparaconate, $\text{Fe}(\text{OH})(\text{C}_{13}\text{H}_{11}\text{O}_5)_2$, and ferric chloride.

The ethylic salt of the lactone of oxalcitric acid yields with ferric chloride in absolute ether solution a red oil, which does not solidify, and is most probably an addition product, represented by the formula $\text{FeCl}_3\text{C}_{14}\text{H}_{18}\text{O}_9$. It loses hydrochloric acid slowly in a vacuum. On treatment with water, it yields the ferric salt of the lactone of ethylic oxalcitrate, $\text{Fe}(\text{C}_{14}\text{H}_{17}\text{O}_9)_3$, and ferric chloride.

In the case of ethylic acetoacetate and ethylic benzaldiacetoacetate purple oils are obtained by the action of anhydrous ferric chloride. The purple substances have not as yet been prepared in a sufficiently pure state to justify the authors in assigning formulæ to them.

***36. "Note on the volatility of sulphur." By T. C. Porter, M.A., &c.**

During the analysis of some pumice rock from Tenerife, the author was led to the conclusion that sulphur is volatile at 100° . Several glass tubes were carefully cleaned, into which specimens of sulphur of varying physical condition and purity were placed. Some of the tubes were exposed to the air, others were exhausted. After being exposed to a temperature of 100° for some minutes, it was observed that, as was to be expected, the better the vacuum, the more rapid is the sublimation of the sulphur. The sublimate consists at first of very pale yellow drops, which possess little viscosity, and remain unchanged in some cases even at 10° for days. Rhombic octahedra and prismatic sulphur are occasionally formed together, the former crystals sometimes grow at the expense of the drops. Sulphur does not yield a perceptible sublimate at ordinary temperatures, in a "good vacuum," even after a year. The two forms S_α and S_β therefore have their transition point between 90° and 100° .

DISCUSSION.

Professor McLEOD said that about 1870 Mr. Douglas Herman had experimented on the volatility of various substances in vacuous tubes, although he believed the results have never been published. Mr.

Herman found that sulphur could be volatilised in a vacuum when heated to the temperature of boiling water, and that the vapour condensed in drops on the cool parts of the tube, and remained liquid for many days. Octahedral crystals were formed at the expense of the drops in the neighbourhood of the crystals, the drops gradually evaporating whilst the crystals increased in size; prismatic crystals were very rarely seen. When phosphorus is heated in vacuo by the warmth of the hand, its vapour also is deposited in drops, although, as in the case of sulphur, the vapour had not been heated to the melting point of the solid. Iodine at once forms crystals under similar conditions, no liquid being deposited.

The PRESIDENT said that, in a lecture on liquid atmospheric air in 1893 (*Proc. Roy. Inst.*, 14, 7), he had described the use of sulphur in the construction of vacuum vessels for the storage of liquid air, and had shown that in such vacua cooling with liquid air or oxygen was sufficient to produce a visible distillation of sulphur at ordinary temperatures. The vapour tension of sulphur at 100° amounts to 0.06 mm., so that the tension is comparatively high in Mr. Porter's experiments, considering that mercury distils rapidly under a pressure of one-millionth of an atmosphere, as shown by the application of liquid air. He also remarked that phosphorus distils practically instantaneously.

*37. "Cannabinol." By T. B. Wood, M.A.; W. T. N. Spivey, M.A.; and T. H. Easterfield, M.A., Ph.D.

The authors have continued their examination of cannabinol, the toxic resinous constituent of Indian hemp (*Trans.*, 1896, 69, 539). The substance boils with slight decomposition at about 400° , its absorption spectrum shows no characteristic bands, its vapour-density at the temperature of boiling sulphur corresponds with the formula $C_{18}H_{24}O_2$, already assigned to the compound.

An account is given of the reaction of cannabinol with acetic anhydride, benzoyl chloride, and phosphoric anhydride; the results indicate that one hydroxyl group is present. In the case of acetic anhydride or acetyl chloride, however, a crystalline compound melting at 75° is one of the products of the reaction. The authors assign the formula $C_{15}H_{18}O_2$ to this compound. The same compound has recently been described by Dunstan and Henry (*Proc.*, 1898, 14, 44, Feb. 17) who ascribe the formula $C_{15}H_{23}OAc$ to it. Fuming hydriodic acid gives no methyl or ethyl iodide when boiled with cannabinol. Reduction with hydriodic acid in sealed tubes produces a hydrocarbon, $C_{10}H_{20}$.

By long-continued boiling with or without dehydrating agents, a hydrocarbon, $C_{10}H_{16}$, is formed.

Oxidation with aqueous chromic acid, alkaline, or acid permanganate, or dilute nitric acid is accompanied by the production of a caproic acid, lower fatty acids being probably produced at the same time. The action of fuming nitric acid upon cannabinol dissolved in cold glacial acetic acid removes one carbon atom as carbonic anhydride, and produces a red, amorphous substance which gives numbers on analysis agreeing with the formula $C_{17}H_{20}N_2O_6$. This substance, when boiled with nitric acid, yields a light red substance, $C_{17}H_{20}N_2O_8$, which upon further oxidation yields, amongst other substances, a yellow acid crystalline compound, $C_{13}H_{15}N_2O_5$ which forms sparingly soluble crystalline sodium, ammonium, and silver salts and is probably a di-nitrophenol, and a compound, $C_{11}H_{11}NO_4$, the properties of which agree closely with those of the "oxycannabin" of Bolas and Francis (*Chem. News*, 1871, 24, 77). This compound has the properties of a nitro-lactone, as has been already shown by Dunstan and Henry (*Proc., loc. cit.*). Corresponding crystalline potassium and silver salts have been prepared and analysed. The name cannabinic acid is proposed for the unnitrated parent oxy-acid.

Amido-cannabinolactone, $C_{11}H_{11}O_2NH_2$, is obtained in colourless crystals melting at 119° , when the nitro-lactone is reduced either by hydriodic acid or by tin and hydrochloric acid. The base is readily recrystallised from hot water, its salts cannot be recrystallised from water without decomposition; the hydriodide and platinochloride have been analysed.

*38. "Contributions to the chemistry of thorium."

By Bohuslav Brauner, Ph.D.

As there are few direct methods of separating the elements of the rare earths, the author investigated the reaction of Bahr (1864), who showed that thorium oxalate is easily soluble in a solution of ammonium oxalate. Bunsen (1876), though he found that the oxalates of the other rare earths are only slightly soluble in that reagent, had to repeat the process of solution many times to obtain a product which did not show in its spark spectrum the lines of other elements.

The reaction is due to the formation of a double thorium-ammonium oxalate, decomposed by water, and existing in solution only in the presence of free ammonium oxalate. After numerous crystallisations, a salt was obtained having the formula $Th(C_2O_4)_2 + 2(NH_4)_2C_2O_4 + 4H_2O$, with one-third to one-half of free $(NH_4)_2C_2O_4 + H_2O$. Finding, however, that the solution readily becomes supersaturated, a compound having the formula $Th(C_2O_4)_2 + 2(NH_4)_2C_2O_4 + 7H_2O$, was obtained in such a high state of purity that from its analysis the atomic weight of thorium, $Th = 232.59$, could be calculated.

This "complex" salt is ammonium thoroxalate. It is decomposed by water, but a definite quantity of the soluble product of decomposition dissolves the insoluble constituent, so that one part of water keeps one part of ammonium thoroxalate in solution if an additional half-molecule of free ammonium oxalate is present. The salt forms two hydrates, in accordance with Potilizin's law that a compound forming supersaturated solutions exists in several hydrate forms, one with $7\text{H}_2\text{O}$, the other with $4\text{H}_2\text{O}$. The former loses water in air of average humidity, passing into the latter form, which becomes anhydrous in perfectly dry air, or more readily at 100° , without loss of ammonia. On heating at higher temperatures, large quantities of cyanogen gas are evolved.

The amount of the decomposition of the salt caused by increasing the quantity of water was determined, together with the proportion of ammonium oxalate required to prevent decomposition. Three mols. of ammonium oxalate form, with one mol. of thorium oxalate, a clear solution in 300 mols. of water. This solution is, however, supersaturated with thorium oxalate, the latter separating until their relative proportions become 3.3 : 1. A convenient method for the purification of thorium may be based on these results, as the author has determined quantitatively the great difference in solubility between the oxalate of the feebly basic tetravalent thoria and those of the other trivalent rare earths in ammonium oxalate. The rule was thus established: "the tendency to form complex oxalates is inversely proportional to the basicity of an earth." This, and another property of oxalates, that their stability under the oxidising action of nitric acid decreases considerably with an increasing basicity of the earth, was utilised for the purification of thorium.

On precipitating a solution of ammonium thoroxalate with oxalic acid, an acid thorium oxalate—thoroxalate of thorium and hydrogen—is formed, having the formula $\text{H}_2\text{Th}_2(\text{C}_2\text{O}_4)_5 + 9\text{H}_2\text{O}$. On using mineral acids (Glaser, *Zeit. Anal. Chem.*, 1897, 36, 216; 1898, 37, 25), a different result is observed.

***39. "On the atomic weight of thorium." By Bohuslav Brauner, Ph.D.**

The author determined the purity of the material, obtained as described above, by the spark spectrum, and by atomic weight determinations. He determined in the air-dry oxalate (*a*) the thorium tetroxide by heating, and (*b*) the percentage of C_2O_3 by means of a solution of potassium permanganate. The first series of experiments gave concordant results, leading to the value $\text{Th} = 233.3$, a value not in agreement with that previously obtained by him, $\text{Th} = 232.59$.

Further study showed that the oxalate used was contaminated with basic salt, and a normal oxalate being prepared, the following values were obtained as a result of five series of experiments made with different preparations. Th = 232·50, 232·46, 232·45, 232·31, 232·33, 232·50, 232·44, and 232·35 ; average, Th = 232·42.

This number agrees with that obtained by Krüss and Nilson, Th = 232·45. The author then investigates the conditions which led him to obtain the high value in the first series, approaching the value of Cleve, Th = 234·5. The work of other investigators is vitiated by untrustworthy methods and impure material.

***40. "On the compound nature of cerium." By Bohuslav Brauner, Ph.D.**

The author showed in 1882 (*Trans.*, 41, 68 ; *Monats.*, 3, 486) that cerium from cerite is associated with an element whose higher oxide forms yellow and lower white salts, though the higher oxide is far less stable than cerium tetroxide. The substance is found with lanthanum and didymium when separating cerium by Bunsen's method. In 1885, the author showed (*Trans.*, 47, 879) that the substance remains in the mother liquor after the bulk of the cerium sulphate has crystallised, and may be precipitated from it by alcohol. Schützenberger has repeated the author's experiments without mentioning his name. After applying Debray's method of separating cerium to these fractions and again fractionating, the author obtained substances with the following values for the atomic weights. The method employed was the analysis of the oxalate, and the determination of 'active' ozonic oxygen by Bunsen's method in the oxide obtained by calcination, the latter number being given in parenthesis: $R''' = 140\cdot25$ (4·64), 140·22 (4·65), 140·12 (4·81), 140·00 (4·65), 140·01 (4·59), 139·65 (4·61), 139·16 (4·01), 138·72 (4·51), 136·50 (3·31), 135·43 (3·93), 132·07 (3·73), 130·70 (3·21). As the value of the atomic weight decreases, the colour changes from white to a reddish-brown orange.

The quantity of 'active' oxygen, therefore, decreases almost in proportion to the decrease in value of the atomic weight. If we assume that the 'active' oxygen is due entirely to the cerium present, the value of the atomic weight of the other element may be calculated at about 110. The author has thoroughly investigated the spark spectrum of the lower fractions, but has found no characteristic line, other than those of cerium. In one case only were traces found of the two characteristic groups of lines in the red belonging to yttrium. No appreciable amount of yttria could be found, however, in the solution, even when a large quantity of the material in question was treated with potassium sulphate. As terbium forms a higher

oxide of an orange colour, the colour of the lower fractions of cerium may be due to its presence, but as its atomic weight is higher than that of cerium, another earth of lower atomic weight must still be present, and it is not improbable that, like gadolinum, this element may give no characteristic spectrum. The recent controversy between Wyruboff and Boudouard (*Compt. rend.*, 1897, 125, *pass.*) has led the author to publish the result of this research, which has occupied him many years.

***41 "On praseodidymium and neodidymium." By Bohuslav Brauner, Ph.D.**

Applying Mendeléef's method of crystallisation of the double nitrates with ammonium nitrate to a mixture of lanthanum and didymium, Auer von Welsbach (1885) succeeded in splitting up the old didymium into "praseodym" and "neodym." Praseodidymium, according to him, has an atomic weight $\text{Pr} = 143.6$, and forms two oxides, Pr_2O_3 and Pr_4O_7 . The higher oxide is black-brown, the lower forms green salts with a characteristic spectrum. Neodidymium $\text{Nd} = 140.8$ gives only one oxide, Nd_2O_3 with pink salts possessing eleven absorption bands. Nothing of importance has been added to our knowledge on the subject during the last 11 years.

The author spent several years in repeating Welsbach's work, but last year he obtained from Dr. Waldron Shapleigh, in Gloucester, N.J., a quantity of highly purified research material.

From this mixture (40 grams of praseodidymium oxide with 20 grams of lanthanum oxide) the latter was removed, the former being converted by fusion with nitre into the oxide Pr_2O_4 . This was purified by fractionating with ammonium nitrate solution, ammonia, and oxalic acid.

A preliminary determination of the atomic weight gave the value $\text{Pr} = 140.8$. The analysis of the oxalate and the synthesis of the sulphate gave thirteen numbers, varying between 140.84 and 141.19, the average being $\text{Pr} = 140.95$. The lower oxide, Pr_2O_3 , is of a beautiful pale green colour, and the spectrum of its green salts contains the absorption bands $\lambda = 5968, 5895, 4812, 4693$ and 4447 (Rowl.) Praseodidymium trichloride gives a characteristic spark spectrum.

Salts of the trioxide having the following formulæ have been prepared and analysed by the author:— $\text{Pr}_2(\text{SO}_4)_3$, $\text{Pr}_2(\text{SO}_4)_3 + 6\text{H}_2\text{O}$, $\text{Pr}_2(\text{SO}_4)_3 + 8\text{H}_2\text{O}$, $\text{Pr}(\text{NO}_3)_3 + 2\text{NH}_4\text{NO}_3 + 4\text{H}_2\text{O}$, $\text{PrAc}_3 + \text{H}_2\text{O}$, $\text{Pr}_2(\text{C}_2\text{O}_4)_3 + 10\text{H}_2\text{O}$.

According to Professor Vrba's measurements, the salt $\text{Pr}_2(\text{SO}_4)_3 + 8\text{H}_2\text{O}$ is isomorphous with $\text{Y}_2(\text{SO}_4)_3 + 8\text{H}_2\text{O}$ and other sulphates of this type. This fact, and the slight solubility of the oxalate in ammonium oxalate,

prove that the formula of the lower oxide is Pr_2O_3 , and not Pr_2O_4 or Pr_2O_5 , in which cases the atomic weight would be 188 or 235. The tetroxide, Pr_2O_4 , obtained from the nitrate on heating to a temperature of 440° , or by fusion with nitre at 400° , is jet-black, but it becomes dark brown in a state of fine division.

Up to the present, only its basic salts have been obtained; the sulphate, $2\text{Pr}_2\text{O}_4 \cdot \text{SO}_3 + 2\frac{1}{2}\text{H}_2\text{O}$, and the basic acetate in acetic acid solution, having a formula which may be represented by either $\text{Ac}_3\text{—Pr}^{\text{IV}}\text{O—Pr}^{\text{IV}}\text{—(OH)}_3$, or $\text{Ac}_2\text{—Pr}^{\text{III}}_2\text{O}_2\text{—OH} \cdot \text{Ac} + \text{H}_2\text{O}$. The double fluorides are being investigated.

It is of the greatest importance to know whether the tetroxide is (a) a true oxide of the water type, with ozonic oxygen (like lead tetroxide, PbO_2), in which case the praseodidymium would be tetravalent, or (b) a true peroxide of the hydrogen peroxide type, with ant-ozonic oxygen (like barium peroxide, BaO_2), in which case the metal would be trivalent. With regard to the first view, it yields, with dilute acids, free oxygen, and the solution does not reduce potassium permanganate (negative test for hydrogen peroxide). On treatment with concentrated nitric and sulphuric acids, oxygen containing much ozone is evolved, and with hydrochloric acid chlorine is set free, arising probably from the decomposition of the unstable perchloride, PrCl_4 (?). Like other ozonic oxides of the water type, it presents with hydrogen peroxide the phenomenon of catalysis in the presence of dilute sulphuric acid, a quantity of the hydrogen peroxide being oxidised, strictly equivalent to the 'active' oxygen lost by praseodidymium tetroxide according to the equation: $\text{Pr}_2\text{O}_4 + \text{H}_2\text{O}_2 + 3\text{H}_2\text{SO}_4 + \text{Aq} = \text{Pr}_2(\text{SO}_4)_3 + \text{O}_2 + 4\text{H}_2\text{O} + \text{Aq}$.

On the other hand, praseodidymium tetroxide gives with ether, water, sulphuric acid, and potassium bichromate an intensely blue coloration (Baresville's reaction) according to the equation $\text{Pr}_2\text{O}_4 + 3\text{H}_2\text{SO}_4 + \text{Aq} = \text{Pr}_2(\text{SO}_4)_3 + \text{H}_2\text{O}_2 + 2\text{H}_2\text{O} + \text{Aq}$. In the treatment, therefore, of the tetroxide with dilute sulphuric acid both reactions take place simultaneously, and the result is the evolution of oxygen, $2\text{Pr}_2\text{O}_4 + 6\text{H}_2\text{SO}_4 + \text{Aq} = 2\text{Pr}_2(\text{SO}_4)_3 + \text{O}_2 + 6\text{H}_2\text{O} + \text{Aq}$.

Praseodidymium tetroxide is, therefore, an oxide of a new kind, belonging simultaneously to the ozonic oxides of the water type, and to the antozonic oxides of the hydrogen peroxide type; it is, in fact, the missing link between these two hitherto entirely different types of peroxides, its active oxygen being at the same time both entirely ozonic and entirely antozonic.

The basic acetate of the tetroxide, which is nearly white, and in the spectrum of which the blue absorption bands are invisible when seen by reflected light, though the yellow band remains unchanged (an indication of the complex nature of praseodidymium), is the salt of an

oxide belonging to the hydrogen peroxide type, for it reduces potassium permanganate quantitatively and gives Baresville's reaction for hydrogen peroxide. It is, however, so remarkably stable that it does not part with all its active oxygen even after being boiled for an hour with concentrated caustic potash solution.

As regards the author's neodidymium, its absorption spectrum contains the bands $\lambda = 7283, 7080, 6905, 6368, 6279, 6247, 5788, 5323, 5211, 5097, 5063$ and 4280 . It contains, in addition to these, a strong, sharp band of wave-length $\lambda = 4694$ which differs in character and position from the praseodidymium band $\lambda = 4693$. There were also traces of Pr 4812 and Pr 4447, Dy 4752 and 4605 (Sm. series?).

The value of the atomic weight of neodidymium found after the first purification of the material by treatment with oxalic acid was $Nd = 143.4$, after another purification, $Nd = 143.63$. Its lower oxide, having the formula Nd_2O_3 , is of a beautiful pink colour with an amethyst tint, whereas the higher oxide contains a little more oxygen than corresponds to the formula Nd_2O_5 (the author's old Di_2O_5). Neodidymium also gives two series of salts, the acetate of the higher oxide being nearly white. According to a quantitative analysis, by comparing the intensity of the bands the author's neodidymium contained 2.9 per cent. praseodidymium, whereas the old didymium from cerite contained in 100 parts of the oxide 78.8 parts Nd_2O_3 and only 21.2 per cent. Pr_2O_3 .

With regard to the position of these elements in the periodic system, the author concludes from the tendency of them both to become more highly oxidised than would correspond to the formulæ Pr_2O_4 and Nd_2O_5 , that praseodidymium and neodidymium may be further split up. This is regarded as very probable by all rare earth chemists. The pure oxides will probably be found to have the formulæ Pr_2O_5 and Nd_2O_6 , so that the eighth series of the periodic system would assume the following form:—

^I Cs.	^{II} Ba.	^{III} La.	^{IV} Ce.	^V Pr.	^{VI} Nd.
133	137.4	138.2	139.7	141	143.6

DISCUSSION.

The PRESIDENT congratulated Professor Brauner on the valuable scientific results he had presented to the Society, and on behalf of the members expressed their appreciation of the motives which had induced the author to come all the way from Prague to communicate four papers of such great importance to the Chemical Society. He wished him success in the continuation of such laborious and intricate investigation.

42. "Action of ammonia and substituted ammonias on acetylurethane." By George Young, Ph.D., and Ernest Clark.

Acetylurethane has been subjected to the action of ammonia and of substituted ammonias under varying conditions as to solvent, temperature, and pressure. The general results of the investigation show that action takes place principally according to the equation, $\text{MeCONHCO}_2\text{Et} + \text{NH}_2\text{R} = \text{MeCO}\cdot\text{NH}\cdot\text{CO}\cdot\text{NHR} + \text{EtOH}$. Under certain conditions, the products point to the action having resulted in the formation of acetamidine urethanes, $\text{MeCO}\cdot\text{NHCO}_2\text{Et} + \text{NH}_2\text{R} = \text{Me}(\text{NHR})\text{C}\cdot\text{N}\cdot\text{CO}_2\text{Et} + \text{H}_2\text{O}$. These acetamidines have not been isolated, but in their place the products of hydrolysis, acetamide and substituted acetamides, have been obtained, $\text{Me}(\text{NHR})\text{C}\cdot\text{N}\cdot\text{CO}_2\text{Et} + 2\text{H}_2\text{O} = \text{Me}\cdot\text{CO}\cdot\text{NHR} + \text{NH}_3 + \text{CO}_2 + \text{EtOH}$. Ammonia and methylamine enter into action most easily, piperidine, aniline, the naphthylamines and phenylurea less so. Acetylurea, acetanilide, and diphenylamine appear to be without action.

43. "Formation of oxytriazoles from semicarbazides." By George Young, Ph.D., and Benjamin Mitchell Stockwell, B.Sc.

This paper contains an account of the formation of oxytriazoles according to the equation $\text{R}\cdot\text{NH}\cdot\text{NH}\cdot\text{CO}\cdot\text{NH}_2 + \text{C}_6\text{H}_5\cdot\text{CHO} + \text{O} = \text{R}(\text{C}_6\text{H}_5)\cdot\text{C}_2\text{N}_3\text{OH} + 2\text{H}_2\text{O}$ where R is an aromatic radicle. The following substances are described. *Paratolylsemicarbazide*, m. p. 187—188°. *Acetylparatolylsemicarbazide*, m. p. 212.5°. *Benzoylparatolylsemicarbazide*, m. p. 218°. *Paratolylazocarbamide*, m. p. 142°. *5-Phenyl-1-paratolyl-3 oxytriazole*, m. p. 242°. *Acetylphenylparatolyl-oxytriazole*, m. p. 112—113°. *Benzoylphenylparatolyl-oxytriazole*, m. p. 132°. *Phenylparatolylethoxytriazole*, m. p. 51—52°. *β-Naphthylsemicarbazide*, m. p. 225°. *Phenyl-β-naphthyl-oxytriazole*, m. p. 274—275°. *Acetylphenyl-β-naphthyl-oxytriazole*, m. p. 142—143°. *Benzoylphenyl-β-naphthyl-oxytriazole*, m. p. 141—142°. *Metanitrophenylsemicarbazide*, m. p. 195°. *Benzoylmetanitrophenylsemicarbazide*, m. p. 188—189°. *Metanitrophenylazocarbamide*, m. p. 168—169°. *5-Phenyl-1-metanitrophenyl-3-oxytriazole*, m. p. 235°. *Acetylphenylmetanitrophenyl-oxytriazole*, m. p. 130—132°. *Benzoylmetanitrodiphenyl-oxytriazole*, m. p. 168°. *Nitrodiphenylethoxytriazole*, m. p. 96°.

44. "Formation of *aa'*-dihydroxypyridine." By S. Ruhemann, Ph.D., M.A.

Ethyl *aa'*-dihydroxydinicotinate (*Proc.*, 1898, 14, 47) when boiled with concentrated hydrochloric acid, yields the hydrochloride of *aa'*-dihydroxypyridine, from which ammonia sets free the base (m. p.

192—193°). The same substance is obtained from Guthzeit and Dressel's monethylic ethoxypyridonedicarboxylate (*Annalen*, 1891, 262, 113) by boiling hydrochloric acid.

45. "Position-isomerism and optical activity; the comparative rotatory powers of diethylic mono-benzoyl and mono-toluyll tartrates." By Percy Frankland, F.R.S., and J. McCrae, Ph.D.

The authors review the present state of knowledge concerning the relative rotatory powers of the phenyl and three toluyll derivatives of optically active compounds, and point out that whilst of the three isomeric toluyll groups, the ortho- has almost invariably the least, and the para- the greatest, rotatory influence, the rotatory influence of the phenyl-group is in some series greater, and in some less, than that of any one or of all of the toluyll groups.

As a contribution to this study, the authors have prepared the compounds mentioned above, and have determined their rotations in a fused state over a wide range of temperature, whilst they have also determined the molecular weight and rotation of each in glacial acetic acid solution, with a view of ascertaining the relative rotations of the compounds in the monomolecular condition.

The following are the specific rotations at 100° for each of the compounds, as well as of diethylic tartrate, from which they may be regarded as derived.

Diethylic tartrate.....	$[\alpha]_{\text{D}}^{20^\circ} = + 7.66^\circ$	$[\alpha]_{\text{D}}^{100^\circ} = + 15.77^\circ$
„ monobenzoyltartrate..	$[\alpha]_{\text{D}}^{24^\circ} = + 20.71^\circ$	$[\alpha]_{\text{D}}^{99.5^\circ} = + 17.69^\circ$
„ mono- <i>o</i> -toluylltartrate.	$[\alpha]_{\text{D}}^{30^\circ} = + 11.82^\circ$	$[\alpha]_{\text{D}}^{100^\circ} = + 10.88^\circ$
„ „ <i>-m-</i> „	$[\alpha]_{\text{D}}^{20^\circ} = + 13.59^\circ$	$[\alpha]_{\text{D}}^{100^\circ} = + 12.57^\circ$
„ „ <i>-p-</i> „		$[\alpha]_{\text{D}}^{100^\circ} = + 15.85^\circ$

Thus the dextrorotation of diethylic tartrate increases with rise of temperature, whilst that of the above monacidyl tartrates diminishes. In glacial acetic acid solution, the benzoyltartrate has a lower rotation than the para-toluylltartrate, but otherwise the above order of the rotations is unchanged. In all cases the rotation in glacial acetic acid solution was considerably lower than that of the pure substance, but this difference is not attributable to the pure substance in the fused state being associated, for the rotation of the diethylic monobenzoyltartrate in benzene solution was even lower still, and yet in benzene solution it is more probable that there would be association than in glacial acetic acid. Thus from the results in benzene it would appear that association of the benzoyl compound is attended with diminution in the rotation, so that the higher rotation of the liquid benzoyl compound itself cannot

be due to association also. Neither do the molecular volumes of these compounds point to association when interpreted by Traube's formula.

Diethylic monobenzoyletartrate has been previously prepared by Guye and Fayollat (*Bull. Soc. Chim.*, 1895, [iii], 13, 201), their preparation was admittedly impure, and yielded a very much lower rotation and melting point. It was first prepared by Perkin (*Trans.*, 1867, 20, 138), but without determining the rotation, the melting point which he obtained was almost exactly the same as that found by the authors.

46. "The action of di-isocyanates upon amido-compounds." By H. Lloyd Snape, D.Sc., Ph.D.

By the action of diphenylenedi-isocyanate upon phenylhydrazine in ethereal solution, *diphenylenedi-phenylsemicarbazide*, $\text{Ph} \cdot \text{NH} \cdot \text{NH} \cdot \text{CO} \cdot \text{NH} \cdot \text{C}_6\text{H}_4 \cdot \text{C}_6\text{H}_4 \cdot \text{NH} \cdot \text{CO} \cdot \text{NH} \cdot \text{NH} \cdot \text{Ph}$, was obtained. The product was a white powder which was insoluble in the more common organic solvents. It gave with copper sulphate a chocolate-brown colour, which was changed to green on the addition of ammonia.

Toluylenedi-phenylsemicarbazide, $\text{Me} \cdot \text{C}_6\text{H}_3(\text{NH} \cdot \text{CO} \cdot \text{NH} \cdot \text{NH} \cdot \text{Ph})_2$, (1:2:4) was prepared by acting with 1:2:4-toluylenedi-isocyanate on an ethereal solution of phenylhydrazine. The product, after recrystallisation from alcohol, consisted of colourless crystals which decomposed and rose in a capillary tube at 203° . This carbazide also was insoluble in the more common organic solvents, with the exception of alcohol, in which it was difficultly soluble. With copper sulphate, it gave a wine-red coloration which changed to green on the addition of ammonia.

1:2:4-*Diphenyl-toluylene-diurea*, $\text{Me} \cdot \text{C}_6\text{H}_3(\text{NH} \cdot \text{CO} \cdot \text{NH} \cdot \text{Ph})_2$, was obtained on mixing ethereal solutions of aniline and toluylenedi-isocyanate. The product was recrystallised from alcohol; it formed microscopic needles which melted at 261° with accompanying decomposition. It was difficultly soluble in methyl, ethyl, and amyl alcohol.

1:2:4-*Toluylene-diurea*, $\text{Me} \cdot \text{C}_6\text{H}_3(\text{NH} \cdot \text{CO} \cdot \text{NH}_2)_2$, was prepared by treating an ethereal solution of toluylenedi-isocyanate with ammonia and crystallising the product from water. Minute crystals, which melted with accompanying decomposition at about 252° . It was sparingly soluble in alcohol. Lussy had previously described this reaction, but states that the product melts at 220° .

47. "The action of alkyl iodides on silver malate and on silver lactate." By Thomas Purdie, F.R.S., and G. Druce Lander, B.Sc.

The object of this research was to discover the cause of the abnormally high optical activity of the ethereal malates and lactates pre-

pared by the silver salt method. An abstract of the first part of the paper treating of the action of isopropyl iodide and ethyl iodide on silver malate has already been published as a preliminary note (*Proc.*, 1896, 12, 219). The high activity of the malates, thus prepared, is due to the simultaneous production of ethereal salts of the much more active alkyloxysuccinic acids.

The silver salt of inactive lactic acid acts in a similar manner. With isopropyl iodide, the ethereal salt of (n- or iso-) propoxypropionic acid is produced in considerable quantity. By reactions similar to those employed in the case of silver malate, the substance was separated from the ethereal lactate with which it is mixed, and identified by the analysis of several salts obtained from it. Evidence was also obtained that with ethyl iodide the ethyl salt of ethoxypropionic acid is produced, though in this case, as in the corresponding reaction with silver malate, it was not possible to isolate the salts in the pure state owing to the small quantity of the alkyloxy-acid formed. The authors have recently effected the resolution of several alkyloxypropionic acids by means of alkaloids, and find that these acids are highly active as compared with lactic acid. Their production in the reaction above referred to accounts therefore for the abnormal activity of the ethereal lactates prepared from silver lactate.

The reaction seems to be a general one for the silver salts of hydroxy-acids (see following paper), and cannot therefore be relied on for the preparation of the ethereal salts of these acids in the pure state. With the permission of Mr. Brame, the authors have recently extended his experiments on the action of alkyl iodides on silver tartrate. The results already obtained point to the formation of dialkyloxysuccinates being the cause of the abnormally high activity of the ethereal tartrates thus prepared. The authors are carrying on the research with the view of throwing light on the reaction by which the alkyloxy-acids are produced, and of adapting it, if possible, for the direct preparation of optically active acids of this kind from the corresponding active hydroxy-acids.

48. "On the optical rotations of methyl and ethyl tartrates." By J. W. Rodger and J. S. S. Brame.

The authors, in attempting to prepare the alkyl tartrates in a high state of purity, find that when prepared by saturating an alcoholic solution of the acid with hydrochloric acid, or heating the acid or mono-substituted ester with alcohol in sealed tubes, the rotation of the product is much lower than that obtained for esters prepared by the action of an alkyl iodide on silver tartrate.

Differences of the same nature have been observed by J. Wallace

Walker (*Trans.*, 1895, 67, 914) in the case of the lactates, and by Purdie and Williamson (*Trans.*, 1896, 69, 818) for malates and lactates. With alkyl tartrates, however, the difference in activity is much greater than with lactates or malates. Further, the rotation for different specimens of tartrates prepared by the silver method is by no means constant, although every precaution was taken to ensure similar treatment during preparation.

In order to determine any other differences in the esters prepared by these different methods, samples of methyl tartrate giving these different optical activities were hydrolysed with excess of sodium hydrate, when the products of hydrolysis gave practically the same rotations. Secondly, no difference in the refractive indices was found; and on combustion of methyl and ethyl tartrates prepared by different methods and varying widely in rotation, no real difference in the percentage of carbon could be detected.

These abnormal results for the rotations may be explained on three hypotheses. The low rotation of the ethereal salts prepared by hydrochloric acid saturation or by the sealed tube method may be due to racemisation. Second, the esters from the silver salts may be isomeric with and more active than those prepared by other methods; or third, the esters prepared from silver salts may be contaminated with some much more optically active substance.

The first hypothesis is precluded by the constancy of the rotations obtained by the authors for specimens prepared by three different methods and the agreement with the rotations observed by others with these substances. The second is improbable, but receives some support from the result of hydrolysis. With regard to the third hypothesis, Purdie and Lander in a preliminary note on the action of alkyl iodides on silver malate (*Proc.*, 1896, 12, 221) ascribe the higher rotation given by the malates so obtained to the presence of "small quantities of the ethereal salts of the highly active alkyloxy-acids." The same explanation may hold with the tartrates, in which case these derivatives must be highly active, for they can only be present in small amount, since there is no appreciable rise in the percentage of carbon found. If the high rotation for tartrates prepared from silver salts is due to this cause, then the agreement of results obtained on hydrolysis is only a coincidence.

ANNIVERSARY MEETING.

The Anniversary Meeting will be held on Thursday, March 31st, at 3 o'clock in the afternoon.

At the next Ordinary Meeting, on Thursday, April 21st, there will be a ballot for the election of Fellows.

CERTIFICATES OF CANDIDATES FOR ELECTION.

N.B.—The names of those who sign from “General Knowledge” are printed in *italics*.

The following Candidates have been proposed for election. A ballot will be held on Thursday, April 21st.

Coupe-Annable, Henry William,
University College, Sheffield.

Chemical Assistant. For six years Chemical Assistant to Prof. Williams, University College, Sheffield. Author (jointly with Dr. G. Young) of paper, “Formation of substituted Oxytriazoles from Semicarbazides,” *Proc.*, 1897, also paper “Benzoylphenylsemicarbazide,” *Trans.*, 1897.

W. Carleton Williams.

L. T. O'Shea.

George Young.

Fred Ibbotson.

William H. Oates.

Abbott, Albert,

Church Street, Adlington, Chorley, Lancashire.

Schoolmaster. B.A., Oxford. First Class in Chemistry in Final Honour School. Formerly Science Master at the Marling School, Stroud; for last 2½ years Science Master at the Grammar School, Doncaster.

J. Mitchell Wilson.

John Watts.

V. H. Veley.

J. E. Marsh.

W. W. Fisher.

John William Young.

Baskerville, Charles, B.S., Ph.D.

University of North Carolina, Chapel Hill, N.C.

Assistant Professor of Chemistry Univ. of North Carolina, Assist. Chemist to North Carolina Geolog. Survey. Grad. in Chem. Univ. of Va, P.G. Student Vanderbilts University. Studied in 1893 under Dr. Emil Fischer, Univ. of Berlin. Ph.D., Univ. N.C. 1894. Instructor in, then Assist. Prof. of Chem. Univ. of N.C., Secy. Section C. Am. Assist. of Adv. Science. Author "Separation of Zirconium by SO_2 ," "Rapid Method Determination P. in Titaniferous Iron Ores," "Reactions between Copper and H_2SO_4 ," "Reaction between Mercury and H_2SO_4 ," and others. Co-author with Dr. F. P. Venable, "Sulphites of Zirconium," "Zirconium Oxalates," &c.

J. W. Mallet.

W. L. Dudley.

F. P. Venable.

Marcus Benjamin.

F. P. Dunnington.

Jas. Lewis Howe.

Brierley, Joseph,

Ashton Road, Failsworth, Manchester.

Assistant Lecturer in Chemistry at the Technical College, Huddersfield. B.Sc. (Victoria) Associate of The Owens College.

Harold B. Dixon.

G. H. Bailey.

J. H. Wolfenden.

S. G. Rawson.

W. H. Perkin, junr.

Campion, Alfred,

637, Alexandra Parade, Dennistoun, Glasgow.

Chemist to Steel Co. of Scotland, Ltd., Blochairn Works, Glasgow. Three years' training at Finsbury Technical College, London. Chemical Lecture Assistant for $3\frac{1}{2}$ years at R.I.E. College, Cooper's Hill, Staines. At present Chemist at Blochairn Steel Works. Associate of the Institute of Chemistry.

R. Meldola.

Herbert McLeod.

J. E. Stead.

F. E. Matthews.

F. W. Harbord.

Caven, Robert Martin,

University College, Nottingham (private address—The Tower House, Park Row, Nottingham).

Lecturer and Demonstrator in Chemistry. B.Sc. Lond., F.I.C. For upwards of two years Assistant in the Laboratory of the City Analyst, Birmingham. Since September, 1895, Lecturer and Demonstrator in Chemistry, Nottingham. Author of the following papers: January, 1896, *J.S.C.I.*, "On some Properties of Ferric Phosphate."

January, 1897, *J.S.C.I.*, "Some Properties of Certain Metallic Phosphates," in conjunction with A. Hill. November, 1897, *Proc.*, "The Action of Magnesium on Cupric Sulphate Solution," in conjunction with F. Clowes, D.Sc. December, 1897, *J.S.C.I.* "The Estimation of Cuprous Oxide by means of Standard Potassium Permanganate Solution," in conjunction with A. Hill.

Frank Clowes.

F. Stanley Kipping.

Alfred Hill.

J. J. Sudborough.

William A. Tilden.

L. Archbutt.

Hudson-Cox, Fredk.,

67, Surrey Street, Sheffield.

Analytical Chemist. For three years a Student of Chemistry at the School of the Pharmaceutical Society, and for one year a Student of Physics at University College, London. Associate of the Institute of Chemistry. Assistant to Mr. A. H. Allen.

Wyndham R. Dunstan.

Arthur P. Luff.

Thos. Stevenson.

Alfred H. Allen.

G. E. Scott-Smith.

Dudley, Charles Benjamin,

Drawer 334, Attoona, Penn., U.S.A.

Chemist, Pennsylvania Railroad Company. Ph.D. from Sheffield Scientific School of Yale College, 1874. Instructor Univ. of Penn., 1875. Chemist Penna., R.R.Co., 1875 to date. Published investigations on the Chemistry and Wear of Steel Rails, 1878—82. Also a series of articles on "Chemistry applied to Railroads" in 1889—1897. Many isolated papers on various Metallurgical and Chemical subjects. Prest. Am. Chemical Society, 1896 and 1897.

Charles F. Chandler.

S. A. Goldschmidt.

H. T. Vulté.

Jas. S. C. Wells.

Arthur H. Elliott.

Elwyn Waller.

Fleming, John Arnold,

Britannia Pottery, Glasgow.

Potter. Practical Manager of a Pottery. Studied Analytical Chemistry under Dr. Readman, Edinburgh. Attended Dr. Stevenson Macadam's Lectures in Edinburgh, taking the First Class Medal of the year, and have continuously made chemical investigations in connection with my work.

Stevenson Macadam.

John Clark.

G. H. Gemmell.

A. Humboldt Sexton.

R. R. Tatlock.

G. G. Henderson.

Edw. C. C. Stanford.

Garside, Arthur Leonard Harry,

C/o Messrs. Lawes and Co., Ltd., Barking Creek, Essex.

Analytical Chemist. Formerly Student in Chemistry, Physics, &c., at the Vivian Institute, Torquay, under C. W. Priestley, Esq., B.Sc., A.R.C.S. (Lond.) and at other Institutions. From 1895—97 Demonstrator in Chemistry, &c., at the Science and Art Schools of Torquay and Paignton. Since March, 1897, Assistant Chemist to the Lawes' Chemical Manure Co., Ltd., and Lawes' Chemical Co., Ltd.

Otto C. J. G. L. Overbeck. C. W. Priestley.

Vincent Edwards. J. Theo. Hewitt.

Walter D. Severn. Frank Dixon.

F. Napier Sutton.

Gidden, William Thomas,

108, Vicarage Road, Langley, Birmingham.

Chemist to the British Cyanides Company, Oldbury. Five years Student of Chemistry at Central Technical College; Diploma of Associate of City Guilds Institute in Department of Chemistry. Assistant Demonstrator in Chemistry, East London Technical College, Session 1896—1897. Now Chemist to British Cyanides Company.

Henry E. Armstrong.

Gerald T. Moody.

William H. Davis.

Sidney Williamson.

James C. Philip.

William J. Pope.

Guthrie, Alexander, B.Sc.,

Bocking, Braintree, Essex.

Manager of Saml. Courtauld & Co.'s (Ltd.) Crape-finishing Works. For over four years studied Chemistry practically in Glasgow and Leipzig. For two years Chemist and Sub-Manager in Fish-Products Factory. Over two years Sub-Manager in Chemical Manufacturing Works. For two years Manager of White-Lead Works. Four years in charge of Silk Dyeing and Finishing.

John Ferguson.

James J. Dobbie.

G. G. Henderson.

C. M. Aikman.

Edmund J. Mills.

Heaton, John,

81, Garmoyle Road, Liverpool.

Brewer and Brewers' Chemist. Two years and a half Student of Chemistry under Mr. P. J. Beveridge, M.A., B.Sc., Laboratories Cowley Schools. A course of lectures on Organic Chemistry and Physics Owens College. Honours Technical Brewing, May, 1897, City Guilds Institute.

John Heron.

Arthur R. Ling.

Walter J. Sykes.

Prosper H. Marsden.

Leonard Temple Thorne.

Chas. E. Eastick.

Bernard Dyer.

Hislop, Lawrence,

Gas Works, Uddingston.

Engineer and Manager to Bothwell and Uddingston Gas Company, Ltd. Received my training in Chemistry (both Inorganic and Organic) in Glasgow and West of Scotland Technical College under T. A. Cheetham, Esq., F.C.S.; then for a short time in Messrs. Tatlock's Laboratory, Glasgow. For last five years (in present situation) have been engaged in Analytical work, such as Coal Analysis, Gas Analysis, &c., &c.

Thos. A. Cheetham.

Archd. R. Ormiston.

James Knight.

J. Watson Napier.

William E. Kay.

Hodgson, Harry Pearson,

Caldew Bank, Cummersdale, Carlisle.

Works Chemist. Completed a three years' course of Chemistry at Owens College. Assisted Professor Perkin and Dr. Thorpe in their work on *i*-Camphoronic Acid. In Leopold Cassella's Dye Works at Frankfurt-a-M.

Harold B. Dixon.

D. Lawrence.

W. H. Perkin, jun.

G. H. Bailey.

A. William Gilbody.

Hyland, John Shearson, Ph.D., M.A., F.G.S.

11, Powis Square, Bayswater, London, W.

Mining Engineer and Metallurgist. Studied Chemistry at the University of Leipzig, taking his degree in Chemistry, Physics, and Mineralogy. Author of original investigations on the Chemical Constitution of Minerals, *vide* Tschermak's *Mittheil*, 10, 88, and Scientific Proceedings of the Royal Dublin Society, 6.

W. N. Hartley.

Edward Davies.

Henry A. Miers.

Lazarus Fletcher.

William Crookes.

Jee, Edwin Charles,

45, Pepys Road, New Cross, S.E.

Engaged in Chemical Research at the Central Technical College. B.Sc. (London). Late Assistant Master and Science Teacher at Ormskirk Grammar School, South Lancashire.

Chas. E. Browne.

Henry E. Armstrong.

Gerald T. Moody.

William J. Pope.

Sidney Williamson

Arthur Lapworth.

W. Palmer Wynne.

Jessop, Samuel Morton,
12, Hanson Terrace, Wakefield.

Laboratory Assistant, County Council Laboratory, County Hall, Wakefield. Engaged during past five years on the systematic investigations instituted by the West Riding of Yorkshire County Council into (a) Purification of Rivers, and (b) Plumbo-solvent Action of Moorland Water Supplies. Holds eight Certificates for the Science and Art Department's Examinations in Chemistry, including First Class Honours.

E. Frankland.

B. A. Burrell.

Alfred H. Allen.

Thomas Fairley.

Edward M. Chaplin.

Frank Clowes.

Jones, Edward,
Vine Cottage, Tudor Road, Kingston-on-Thames.

Analyst. Bachelor of Science, London University. Fellow of the Institute of Chemistry. For sixteen years Analyst in the Government Laboratory, London.

T. E. Thorpe.

C. Proctor.

R. Bannister.

J. Woodward.

H. J. Helm.

E. Grant Hooper.

Jones, William,
29, High Street, Wavertree, Liverpool.

Chemist and Dentist. Pharmaceutical 1874, Dental 1878. I desire admission to Chemical Society in order to read the publications of the Society, and so keep in touch with the latest discoveries of Chemical Science.

Arthur W. Warrington.

John W. Towers.

Jos. F. Burnett.

James Grant.

Herbert W. Seely.

F. C. Hartmann.

John Hargreaves.

Lowry, Thomas Martin,
28, St. Lawrence Road, W. Kensington, W.

Assistant in the Chemical Department of the Central Technical College, London, S.W. Diploma of the City and Guilds of London Institute, London University, B.Sc., with First Class Honours in Chemistry and Second Class Honours in Physics. Work on Chlorobromcamphor and on Nitrocamphor (*Proc.*, 1897, 13, 159).

Henry E. Armstrong.

W. J. Pope.

Gerald T. Moody.

Sidney Williamson.

F. Stanley Kipping.

Masson, George Henry,

22, Lauriston Place, Edinburgh.

Doctor of Medicine, Master of Surgery, Edinburgh; Bachelor of Science in the Department of Public Health, Edinburgh. Late Government Analyst under Food and Drugs Act, and Assistant to the Government Analyst, Port of Spain, Trinidad, B.W.I. Late Student Public Health Laboratory, Edinburgh University. Senior Medallist, Class of Practical Chemistry, Edinburgh University, Session 1891—1892.

Alex. Crum Brown.

Leonard Dobbin.

John Hunter.

John S. Ford.

Hugh Marshall.

G. H. Gemmell.

Mitchell, Albert Henry,

Martin's Lane, Tiverton, Devon.

Science Master. Have been engaged in teaching Chemistry since 1890, and for the last three years as Chemistry Master at the Tiverton Technical School. B.Sc. (London) and Honours South Kensington Organic and Inorganic Chemistry. Author of *Quantitative Exercises for Beginners*, Parts I. and II. Student at the Owens College (Evening Classes) 1891 and 1892.

Arthur Harden.

F. Gossling.

G. H. Bailey.

Geo. Stubbs.

J. Woodward.

H. B. Dixon.

Parker, Alfred James,

21, East Hill, Dartford, Kent.

Analytical Chemist. Three years' training Finsbury Technical College, 1st Prizeman in Inorganic and Analytical Chemistry and Organic Chemistry. Honoursman in Practical Inorganic Chemistry, South Kensington. Six years Messrs. Burroughs, Wellcome and Co., Manufacturing Chemists, Dartford, Kent, Analytical Laboratory, and Chemist to the Physiological Department. One and a-half years Messrs. Parke, Davis and Co., Manufacturing Chemists, North Audley Street, W., and Detroit, U.S.A., Consulting Chemist and Superintendent of Laboratory.

J. H. Robbins.

R. Bannister.

R. Meldola.

H. J. Helm.

F. Harwood Lescher.

J. Woodward.

Paters, Walter Charles Cross,

14, Trinity Square, S.E.

Demonstrator of Public Health at Guy's Hospital.

Thos. Stevenson.

John Wade.

Charles E. Groves.

Arthur R. Ling.

William J. Pope.

Ratcliffe, Walter,

21, Mawdsley Street, Bolton.

Analytical and Consulting Chemist, Assayer, &c. Chemist to the Bolton Corporation. Late Chemist to the Dominion Cotton Mills Co., Montreal.

George J. Allen.

Charles A. Fogg.

William B. Mason.

Harold Rostron.

Jno. L. Whiteside.

Smith, Francis Pitt,

77, Woodland Avenue, New Rochelle, N.Y., U.S.A.

Bachelor of Philosophy in the course of Analytical and Applied Chemistry, School of Mines, Columbia University, 1888. Tutor in Chemistry, Columbia University, 1897—98. Analyst, New York City Board of Health, 1890—91. Chemist, U.S. Navy Department, 1892—95. Papers: Editor, *Anthony's Photographic Bulletin*, 1893, "Paint as a Protection for Iron," the Engineers' Club of Philadelphia. Nov. 16th, 1895.

Charles F. Chandler.

Arthur H. Elliott.

Jas. S. C. Wells.

Hermann T. Vulté.

Elwyn Waller.

S. A. Goldschmidt.

Smith, Thomas De,

Eastbourne College, Eastbourne.

Natural Science Master. B.A., late Scholar of Jesus College, Cambridge. 1st Class Natural Science Tripos. 1st and 2nd M.B. Examinations, including Pharmaceutical Chemistry. Natural Science and Mathematical Master, Eastbourne College.

M. M. Pattison Muir.

G. S. Turpin.

S. Ruhemann.

R. S. Morrell.

Charles T. Heycock.

J. E. S. Tuckett.

Somerville, Henry,

33, Vincent Square, S.W.

Lecturer on Chemical Physics at Westminster Hospital Medical School. Senior Lecturer on Chemistry United Westminster School. B.Sc. (London)—[Chemistry and Physics].

A. Dupré.

Jervis E. Foakes.

C. F. Cross.

Edward Bevan.

H. Wilson Hake.

Spivey, William Thomas Newton,
5, Trumpington Street, Cambridge.

M.A. Trinity College, Cambridge. Demonstrator to the Jacksonian
Professor of Natural Philosophy, Cambridge.

James Dewar.

W. J. Sell.

G. D. Liveing.

H. J. H. Fenton.

Thomas H. Easterfield.

St. John, Harry,
Thornfield, Sunderland.

Wine and Spirit Merchant, Brewer and Analytical Chemist. Two
years' Certificate of attendance at Durham College of Science in
Chemistry, Physics, and Mathematics. Two years' pupilage at two
Breweries in Practical Brewing. Two years' pupilage in Analytical
Chemistry applied to Brewing. Two years' pupilage in Analytical
Chemistry under London Analyst. Certificates from South Kensington
in Organic and Inorganic Analysis, Advanced. Member of the Society
of Chemical Industry. General Manager, Head Brewer, and Analyst
to firm of William St. John for past six years.

W. Dixon.

W. H. Blake.

C. Ranken.

H. O. Hale.

William Fowler.

Chas. Wm. Sutton.

Walker, Samuel,
126, Gilmore Place, Edinburgh.

M.A., B.Sc., Edin. Teacher of Chemistry in George Heriot's
Hospital School, Edinburgh. For seven years Teacher in Perth
Academy, and in Sharp's Institute, Perth, and Lecturer to Science
and Art Classes in Chemistry, &c. For twelve years Chemistry Master
in Heriot's School, Edinburgh. Assisted the late Prof. Carnelly in his
investigations on some Derivatives of Diphenyl.

Alex. Crum Brown.

Leonard Dobbin.

Andrew Thomson.

J. Gibson.

W. H. Perkin, jun.

Hugh Marshall.

Williamson, John Alexander,
81, Cheverton Road, Upper Holloway, N.

Analytical Chemist. Student at Glasgow University two years
under Prof. J. Ferguson, M.A., and Prof. G. G. Henderson, M.A.,
D.Sc., F.I.C. ; five years under R. R. Tatlock, F.R.S.E., F.I.C., F.C.S.,
Glasgow ; one year as Chemist in Askam-in-Furness Iron Works,
Lancashire ; two and a half years Laboratory Chemist, and Chemist in
charge of manufacture to the British Explosives Synd., Pitsea, Essex.

At present Analyst to Messrs. Baird and Tatlock, London. Publication in *J.S.C.I.* 1894, p. 1098.

R. R. Tatlock.	John Ferguson.
G. G. Henderson.	Wm. Rintoul.
W. R. Lang.	Horatio Ballantyne.
W. Mackean.	

Wood, Thomas Barlow,
Caius College, Cambridge.

Lecturer on Agricultural Chemistry. M.A. Caius College, Cambridge.

James Dewar.	W. J. Sell.
G. D. Liveing.	H. J. H. Fenton.
Thomas H. Easterfield.	

Woodhead, Samuel Allinson,
Agricultural College, Uckfield, Sussex.

Science Lecturer and Analyst for the County of East Sussex. Lecturer in Chemistry (General and Agricultural) at the Agricultural College, Uckfield. Science Master at the Uckfield Grammar School. Bachelor of Science (Durham). Prizeman in Practical Chemistry. Public Analyst for the County of East Sussex and Town of Hove. Author of paper on Agricultural Chemistry.

P. Phillips Bedson.	F. C. Garrett.
Saville Shaw.	E. H. Farr.
R. Greig Smith.	John M. Thomson.

PROCEEDINGS
OF THE
CHEMICAL SOCIETY.
EDITED BY THE SECRETARIES.

No. 192.

Session 1897-8.

March 31st, 1898. Anniversary Meeting. Professor Dewar, F.R.S.,
President, in the Chair.

Mr. W. G. McMILLAN and Dr. THORNE were appointed Scrutators, and a ballot was opened for the election of Officers and Council for the ensuing year, the ballot being closed at the conclusion of the President's address.

The PRESIDENT, in beginning his address, remarked that the papers submitted to the Society during the past session included original work in all branches of Chemical Science. They have been contributed, not only from the laboratories of the older Universities of Oxford and Cambridge, but also from the University Colleges and other institutions throughout the country. The publications of the Society are, therefore, a complete record of English Chemical Science, and of the researches pursued at different educational centres throughout the country.

The *Proceedings* is now the medium of publication, not only of abstracts of papers which will subsequently appear in the *Transactions*, but also of the rapid publication of short papers and preliminary notices.

The rule, which came into force last year, requiring that authors shall deposit their papers and abstracts with the Secretaries before they are officially announced for reading at a meeting, has worked well; it has made it possible to expedite the publication of the *Proceedings*, and to send advance proofs to the authors for correction.

The meetings have been well attended, the meeting-room being often quite full. Occasionally, interesting discussions have taken place, but as so many of our papers deal with details and matters of fact, anything like a debate must necessarily be of rare occurrence.

The following past Presidents, Lord Playfair, Dr. A. W. Williamson, Sir E. Frankland, Dr. W. Odling, Sir F. A. Abel, Dr. J. H. Gladstone, Sir J. H. Gilbert, this year complete a connection of 50 years with the Society. To mark its sense of the great services they have rendered to Chemical Science, the Council has resolved to entertain them, in the name of the Society, at a dinner on June 9th, given to commemorate their half-century of Fellowship of the Society.

During the past year the Council has had under consideration the question of a revision of the Bye-laws. A Committee was appointed early in the year, which has met several times during the session, but, in view of the wider questions which have occupied the attention of the Council, they have not been able to complete their report.

During the session a section of the Fellows residing at a distance from London have expressed a desire to take part in the election of Officers and Council, without being forced to undertake a journey to London to register their votes at the Annual General Meeting. A Memorial was drawn up, asking the Council to prepare and lay before the Society a Bye-law enabling Fellows to record their votes by post. This Memorial was signed by 540 Fellows, of whom 400 resided outside the London district. In the meantime, the Bye-law Committee had taken steps to ascertain the powers of the Society in this matter under their Charter. They were legally advised that any Bye-law framed to admit voting by post or proxy would be repugnant to the Charter, and therefore invalid.

When the Memorial was presented to the Council, a covering letter contained another suggestion, viz., that it might probably be necessary to obtain a Supplemental Charter, in order to enable the Council to carry out the wishes of the Memorialists. This suggestion was seriously considered by the Council, and further legal opinion was taken on the subject. They were advised that no application for a Supplemental Charter which was not supported by the practically unanimous wish of the Fellows would be listened to by the Privy Council. They have since been further advised that it would be *ultra vires* on their part to expend any part of the funds of the Society in applying for a Supplemental Charter. All the documents relating to the Memorial and the various legal opinions, together with the decisions of the Council, have already appeared in the *Proceedings*, pp. 1, 33, 61 (this volume).

The following eminent foreign chemists, whose names are familiar to us all as of those who have advanced knowledge in various departments of our science, were elected Foreign Members in January of this year, bringing the total number of Foreign Members of the Society up to 38: Professors S. Arrhenius; Th. Curtius; A. P. N. Franchimont; W. Körner; W. Markownikoff; N. A. Menshutkin; H. Moissan; W. Ostwald; F. M. Raoult; I. Remsen; W. Spring; L. J.

Troost ; P. Waage ; J. D. van der Waals. The Society has lost a Foreign Member by death : Professor Victor Meyer, one of the most brilliant and original of the modern school of chemists. The Kekulé Memorial Lecture has been delivered by Professor Japp. It has been resolved that the Memorial Lectures delivered up to 1896 shall be bound and published as Vol. I. of the Society's Memorial Lectures as soon as possible.

The Council have nominated the Treasurer and Editor as delegates for the Society to the National Committee appointed by the Royal Society to prepare a Catalogue of Scientific Literature.

The remainder of the President's address was devoted to an account of recent advances in Low Temperature Research, which will subsequently appear in the *Transactions*.

The numerical strength of the Society was as follows :—

Number of Fellows, March 31st, 1897	2079
„ „ since elected	114
„ „ reinstated by Council.....	4
	<hr/>
	2197
Removed on account of non-payment of two annual subscriptions	17
Withdrawn	22
Deaths	18
	<hr/>
	57
	<hr/>
Number of Fellows, March 31st, 1898	2140
Foreign Members	38

Fourteen Foreign Members were elected during the year.

The names of those removed were:—J. Burgess ; T. R. Carswell ; L. B. Dutson ; W. T. Gibbs ; R. B. Greaves ; T. B. Hall ; E. H. Hill ; P. Hudson ; C. W. Lee ; D. C. Mackenzie ; W. M. Martin ; R. A. Rouillard ; J. W. Slater ; J. W. Smith ; R. M. Sumner ; W. Virtue ; W. H. Walden.

The following have withdrawn :—C. L. Barnes ; J. C. Cain ; W. Johnstoun Coombes ; E. C. Copas ; J. H. Freeman ; D. St. J. Grant ; A. L. Guiterman ; James Hall ; John Howard ; R. E. Hughes ; J. W. James ; A. Luty ; A. Kinninmont ; D. J. Morgan ; E. W. Napper ; E. W. Prevost ; Frederick Quincke ; D. H. Richards ; A. E. Richardson ; R. Routledge ; W. E. Sim ; E. E. H. Thorne ; C. A. Warren.

The following have died :—J. J. Bowrey ; G. W. Child ; E. H. Gaskell ; B. H. Gibbins ; W. A. L. Hammersley ; S. J. Harris ; Walter Jardine ; G. A. Keyworth ; M. H. Lackersteen ; Samuel Lees ; Herman Lescher ; Thomas Mitchell ; Howard Newton ; F. M. Rimmington ; J. W. Rodger ; Taraprasanna Roy ; W. J. Saint ; James Napier.

The number of communications made to the Society during the year was 127.

One hundred and fourteen papers were published in the *Transactions* for 1897, occupying 1204 pages, whereas in the preceding year 117 papers were published, occupying 1702 pages.

The following were the statistics relating to the Abstracts.

PART I.

	Pages.	No. of Abstracts.
Organic Chemistry	648	1049

PART II.

General and Physical Chemistry		324
Inorganic Chemistry		270
Mineralogical Chemistry		192
Physiological Chemistry.....		168
Chemistry of Vegetable Physiology and Agriculture		158
Analytical Chemistry.....		414
Total in Parts I. and II.		1526
		<hr/>
		1260
		<hr/>
		2575

Eight hundred and fifty volumes had been borrowed from the Library. The additions comprised 78 books, 282 volumes of periodicals, and 36 pamphlets.

Sir W. CROOKES, F.R.S., proposed a vote of thanks to the President, coupled with the request that he would allow his address to be printed in the *Transactions*.

Dr. W. J. RUSSELL, F.R.S., seconded the motion, which was carried by acclamation.

The PRESIDENT having returned thanks,

Dr. THORPE, F.R.S., the treasurer, gave an account of the balance sheet, which he laid before the Society, duly audited.

The receipts had been:—By admission fees and subscriptions, £3827; by sale of Journal and advertisements, £686 3s. 6d.; and by dividends on invested capital, £414 6s. 0d. The expenses had been:—On account of the Journal, £2963 11s. 1d.; on account of the Proceedings, £278 7s. 10d.; on account of the General Index, £182 18s. 1d.; on account of the Library, £307 4s. 9d.; House expenses, £203 6s. 7d.; the total expenditure being £4807 6s. 8d. Grants amounting to £150 had been made to Fellows from the Research Fund during the year.

Dr. GLADSTONE, F.R.S., proposed that the thanks of the Fellows be

tendered to the Treasurer for his services during the past year; this motion was seconded by Dr. STEVENSON, and carried.

The TREASURER, in responding, proposed a vote of thanks to the auditors.

Dr. ATKINSON seconded the motion, which was unanimously adopted, and acknowledged by Mr. R. J. FRISWELL.

Mr. D. HOWARD proposed a vote of thanks to the Officers and Council.

Mr. CASSAL seconded the motion, which was unanimously adopted.

Prof. THOMSON, F.R.S., responded on behalf of the Council.

Dr. B. DYER proposed a vote of thanks to the Editor, Sub-Editor, Abstractors, and Indexers, which was seconded by Mr. R. J. FRISWELL, and carried.

Mr. GROVES, F.R.S., responded.

The Scrutators having presented their report to the President, he declared that the following had been duly elected:—

President: James Dewar, M.A., LL.D., F.R.S.

Vice-Presidents who have filled the office of President: Sir F. A. Abel, Bart., K.C.B., D.C.L., F.R.S.; H. E. Armstrong, Ph.D., LL.D., F.R.S.; A. Crum Brown, D.Sc., LL.D., F.R.S.; Sir W. Crookes, F.R.S.; Sir E. Frankland, K.C.B., D.C.L., F.R.S.; Sir J. H. Gilbert, Ph.D., LL.D., F.R.S.; J. H. Gladstone, Ph.D., D.Sc., F.R.S.; A. Vernon Harcourt, M.A., D.C.L., F.R.S.; H. Müller, Ph.D., LL.D., F.R.S.; W. Odling, M.B., F.R.S.; W. H. Perkin, LL.D., Ph.D., F.R.S.; Lord Playfair, G.C.B., LL.D., F.R.S.; Sir H. E. Roscoe, LL.D., F.R.S.; W. J. Russell, Ph.D., F.R.S.; A. W. Williamson, LL.D., F.R.S.

Vice-Presidents: F. R. Japp, M.A., LL.D., F.R.S.; G. D. Liveing, M.A., D.Sc., F.R.S.; William Ramsay, Ph.D., LL.D., F.R.S.; J. Emerson Reynolds, M.D., D.Sc., F.R.S.; John M. Thomson, F.R.S.; William A. Tilden, D.Sc. F.R.S.;

Secretaries: Wyndham R. Dunstan, M.A., F.R.S.; W. P. Wynne, D.Sc., F.R.S.

Foreign Secretary: Raphael Meldola, F.R.S.

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Other Members of Council: P. Phillips Bedson, D.Sc.; E. J. Percan; H. J. H. Fenton, M.A.; W. Gowland; Otto Hehner; C. T. Heycock, M.A., F.R.S.; D. Howard; Herbert McLeod, F.R.S.; Rudolph Messel, Ph.D.; H. Forster Morley, M.A., D.Sc.; Alexander Scott, M.A. D.Sc.; Arthur Smithells, B.Sc.

At the next meeting, on Thursday, April 21, there will be a ballot for the election of Fellows, and the following papers will be communicated. The authors of those marked * have expressed their intention of being present.

*"The carbohydrates of barley straw." By C. F. Cross, E. J. Bevan, and Claud Smith.

*"Isomeric bornylamines." By M. O. Forster, Ph.D.

*"Some derivatives of benzophenone." By F. E. Matthews, Ph.D.

"Researches on camphoric acid." By S. B. Schryver, Ph.D.

"The yellow colouring matters of some plants containing tannin. Part V." By A. G. Perkin and P. J. Wood.

"The yellow colouring matters of the leaves of *Arctostaphylos uva-ursi*." By A. G. Perkin.

LIST OF FELLOWS.

A new list of Officers and Fellows of the Chemical Society being in course of preparation, it is requested that Fellows will send any alteration of address, without delay, to the Assistant Secretary, Burlington House, London, W.

PROCEEDINGS

OF THE

CHEMICAL SOCIETY.

EDITED BY THE SECRETARIES.

No. 193.

Session 1897-8.

April 21st, 1898. Professor Dewar, F.R.S., President, in the Chair.

Messrs. H. C. Seabrooke, W. W. Cheadle, T. H. Hills, and B. S. Bull, were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. Edwin Dowzard, 30, The Willows, Liverpool; Alexander Grant Russell Foulerton, Dunsdale, Mulgrave Road, Sutton; Oswald Hamilton, Old Stratford, Stony Stratford; George Arthur Jarvis, 66, Millbank, Wellington, Salop; Harry Lancelot Lee, 8, Chichester Street, St. George's Square, S.W.; William Lewins, 43, Exeter Street, Gateshead; Alexander MacGillivray Neilson, Coimbatore, Madras; Henry Trench Waller, Zeehan, Tasmania; Edmund Thomas Whitaker, Swan Hill Court, Shrewsbury; William Ernest Wild, 230, Turton Road, Bromley Cross, near Bolton.

A ballot for the election of Fellows was held, and the following were subsequently declared duly elected Fellows of the Society.

Henry William Coupe-Annable; Albert Abbott, B.A.; Charles Baskerville, B.S., Ph.D.; Joseph Brierley, B.Sc.; Alfred Campion; Robert Martin Caven, B.Sc.; Frederick Hudson-Cox; Charles Benjamin Dudley, Ph.D.; John Arnold Fleming; Arthur L. Harry Garside, B.Sc.; William Thomas Gidden; Alexander Guthrie, B.Sc.; John Heaton; Lawrence Hislop; Harry Pearson Hodgson; J. Shearson Hyland, Ph.D., M.A.; Edwin Charles Jee, B.Sc.; Samuel Morton Jessop; Edward Jones, B.Sc.; Thomas Martin Lowry, B.Sc.; George Henry Masson, B.Sc.; Albert Henry Mitchell, B.Sc.; Alfred James Parker; Walter Charles Cross Pakes; Walter Ratcliffe; Francis Pitt Smith; Thomas de Smith, B.A.; Henry Somerville, B.Sc.; William T.

Newton Spivey, M.A. ; Harry St. John ; Samuel Walker, M.A., B.Sc. ; John Alexander Williamson ; Thomas Barlow Wood, M.A. ; Samuel Allinson Woodhead, B.Sc.

Of the following papers those marked * were read :—

***49. "The carbohydrates of barley straw." By C. F. Cross,
E. J. Bevan, and Claud Smith.**

The authors have continued their investigations of growing barley, extending their observations to the plant under the artificial conditions induced by the removal of the ears at the flowering stage. The diversion of the energies of the plant from its normal seed-bearing function proved to be without influence upon the proportion of furfural-yielding carbohydrates to total carbohydrates. The constancy of this ratio has now been established under the widest possible variations of the conditions of growth, natural and artificial, confirming the conclusions that the furfuroids are assimilated with their special constitutional characters and not formed from hexoses by subsequent processes of oxidation.

By the suppression of the seminal function of the plant, the 'maturation' of the straw was virtually arrested, and this is shown by the chemical constants determined in the straw grown up to the harvesting period after removal of the ear, compared with the straw grown under normal conditions. The cellulose and "permanent tissue" are 30 and 10 per cent. respectively in excess in the normal straw, and conversely the artificial product is much more readily hydrolysed by acids, and the resulting solutions (after neutralisation) are fermented by yeast to a much greater extent.

DISCUSSION.

Dr. VOELCKER, speaking from the practical and agricultural rather than from the theoretical side, enquired what was the influence of these different constituents—pentoses, hexoses, and the like—in determining the value of cereal straws at the various stages of growth. The feeding value of straw depends on the period of cutting, but the constituents determining this value were not known.

The results of the plan adopted of cutting off the ears and thus preventing formation of grain had some analogy with those obtained in keeping a clover crop closely cut down. There was an increase of root growth and a consequent enrichment of the soil by accumulation of nitrogen. It was of interest, therefore, to know what happened in the case of cereal straws similarly treated, and in what respects enrichment took place. If the enquiry could be followed up by actual

feeding experiments, some knowledge of the utility of those different complex substances at which the authors were working would be attained.

Dr. HORACE BROWN said that in the case of barley plants which had been deprived of their fructifying organs the increased percentage of permanent tissue and of cellulose was probably due to the accumulation in the straw of the products of assimilation which under natural conditions would have been utilised by the seed. He also expressed a hope that the authors would soon be in a position to give more definite information about the nature of the fermentable carbohydrates which are produced by the acid hydrolysis of these interesting furfuroids.

Mr. CROSS, in reply, said that he hoped to give effect to some of the suggestions in a repetition of the experiments on a more extended scale during the current season.

***50. "Isomeric bornylamines." By M. O. Forster, Ph.D.**

It has been observed by Leuckart and Bach (*Ber.*, 1887, 20, 104) that when camphor is heated with ammonium formate at 200°, it is converted into the formyl derivative of bornylamine; the base from this derivative melted at 159–160°, and had the specific rotatory power $[\alpha]_D = -18.6^\circ$. By the reduction of camphoroxime with sodium and amyl alcohol, the author has obtained two bases having the empirical formula $C_{10}H_{19}N$; one of these substances melts at 163°, and has the specific rotatory power $[\alpha]_D = +45.5^\circ$, whilst the other melts at 180°, and has $[\alpha]_D = -31.3^\circ$. Having found that the base prepared by the method of Leuckart and Bach is a mixture of these two compounds, the author proposes to retain the name *bornylamine* for the dextro-rotatory base, and as the compounds are not optical antipodes, to term the isomeride *neobornylamine*.

The *formyl*, *acetyl*, and *benzoyl* derivatives, and the *hydrochloride*, *platinichloride*, *carbamide*, *phenylcarbamide*, and *picrate* of both bases have been prepared, and are described in the paper.

***51. "Some derivatives of benzophenone." By Francis Edward Matthews, Ph.D.**

Benzophenone in a moist chloroform solution very readily yields a hexachloride, $C_6H_5Cl_6 \cdot CPh$, on saturation with chlorine and exposure to bright light.

Only one modification of this substance appears to be produced in this manner, and all attempts [to introduce a further six atoms of chlorine into the molecule proved fruitless. No hexachloride could be

obtained from acetophenone. Benzophenone hexachloride crystallises from xylene in brilliant colourless forms melting at 215° . It is a very stable substance, but on heating at a temperature considerably above its melting point, evolves hydrogen chloride and benzoyl chloride, and yields a heavy yellow oil from which trichlorobenzophenone was isolated in the crystalline state.

On decomposition with alcoholic soda, benzophenone hexachloride is decomposed in two directions. One interaction results in the elimination of hydrogen chloride and production of the trichlorobenzophenone, which crystallises from acetone on spontaneous evaporation in large hexagonal prisms or plates, and melts sharply at 131° . The second decomposition is represented by the equation: $C_6H_5Cl_6 \cdot CO \cdot C_6H_5 + NaOH = C_6H_6Cl_6 + C_6H_5 \cdot CO_2Na$, and the resulting benzene hexachloride is decomposed, producing 1:2:4 trichlorobenzene. The benzoic acid produced in the hydrolysis was identified.

Benzophenonehexa chloride on nitration yields a mono-nitro-derivative of the formula $C_6H_5Cl_6 \cdot CO \cdot C_6H_4(NO_2)$, which crystallises in pale yellow needles and melts at 159° . This compound is decomposed by alcoholic soda in the same way as the parent substance. The products are 1:2:4 trichlorobenzene, metanitrobenzoic acid, a small quantity of an azo-compound and metanitrotrichlorobenzophenone. The last substance forms pale yellow hexagonal plates from acetone and melts at 143° .

Benzophenone hexachloride dissolves in hot fuming sulphuric acid, producing a sulphonic acid. From this acid the barium salt was prepared; it crystallises in tufts of needles and contains $7\frac{1}{2}$ molecular proportions of water. It is readily decomposed by alkalis, but as the products do not crystallise well they have not been further examined.

***52 "Experiments on lauronic acid." By S. B. Schryver, Ph.D.**

An attempt was made to prepare an unsaturated isomeride from the ethylic salt of camphanic acid (oxycamphoric acid) in the same way that teraonic acid is obtained from terebic acid (Roser, *Ann.*, 1883, 220, 255). Ethylic camphanate is, however, unacted upon by sodium ethoxide, the reagent used by Roser to bring about the above-mentioned reaction. Lauronic acid was then investigated, and a method is described for its preparation on a large scale. It was oxidised with potassium permanganate, but no definite products were obtained, the acid appearing to be totally oxidised, the potassium permanganate acting on it in the same way as on the tetrahydrophthalic acids investigated by v. Baeyer. For this reason, it was thought that lauronic acid was a hydrogenised benzene derivative. Nitric acid acts on lauronic acid violently, yielding principally oxalic acid. In

addition, however, it forms *nitrocampholactone*, a neutral product of the formula $C_9H_{13}O_2(NO_2)$, and under certain conditions this substance can be obtained in fairly large quantity. It melts at 171° , is insoluble in water, but soluble in most organic reagents. On reduction with zinc dust and glacial acetic acid, it yields the corresponding *hydroxylaminocampholactone*, $C_9H_{13}O_2(NHOH)$, which melts at 148° , reduces Fehling's solution and ammoniacal silver nitrate in the cold, and is soluble in hot water, from which it separates on cooling in the form of twinned, quadratic prisms. The hydroxylamine derivative, on oxidation with ferric chloride, yields *nitrosocampholactone*, $C_9H_{13}O_2(NO)$, a bright-green compound melting at 117° , and very soluble in most organic solvents. Nitrocampholactone, on reduction with tin and hydrochloric acid, yields *aminocampholactone*, $C_9H_{13}O_2(NH_2)$, a compound readily soluble in water, from which it crystallises in large, pearly plates containing water, which melt at 39° , but effloresce in a vacuum, giving an anhydrous substance melting at 66° . The platinichloride decomposes without fusion above 200° , and is a salt, not of the aminolactone itself, but of the corresponding aminohydroxy-acid, $[C_9H_{15}O_3(NH_2)HCl]_2PtCl_4$. The nitroso-compound can also be obtained by the action of nitrogen peroxide on lauronic acid, but was not isolated, as the further action of the peroxide converts it into the nitro-compound, which, indeed, can be more conveniently prepared in this way, as the yield is greater than that obtained by the action of nitric acid. Campholactone also gives a certain amount of nitrocampholactone on treatment with nitric acid.

The hydrochloride of aminocampholactone, on treatment with potassium nitrite, yields *hydroxycampholactone*, m. p. 118° , and a liquid of sweet peppermint-like smell.

If Piloty's recent generalisation (*Ber.*, 1898, 31, 219), that stable nitroso-derivatives can only be derived from hydroxylamines in which the $NHOH$ group is attached to a tertiary carbon atom, be applicable to cyclic compounds, then neither the Bredt nor the Perkin formula can correctly represent the constitution of camphoric acid.

***53. "The drying of ammonia and of hydrogen chloride."**

By H. Brereton Baker, M.A.

In a recent paper (*Ann.*, 1898, 299, 267), Gutmann has described experiments on the action of these gases when dried. He comes to the conclusion that the drying of both gases by phosphorus pentoxide is an impossibility, because they are absorbed by the drying agent in a shorter time than is necessary to dry them. The author has repeated the experiments, and finds that this absorption of the gases, when properly purified and dried by lime and sulphuric acid respectively,

only takes place when the phosphorus pentoxide is impure. When the oxide contains any quantity of metaphosphoric acid, the absorption takes place as rapidly as, and with similar results to, those described by Gutmann. From the construction of the apparatus, as well as from the similarity of the results, it is concluded that moisture was admitted while the phosphorus pentoxide was present, and that the difference between his results and those of the author published in 1894 is readily explained as due to the production of metaphosphoric acid.

With regard to the vapour density of ammonium chloride, it is pointed out that Gutmann's low results are probably due to his having collected the air, driven out of the Victor Meyer apparatus, over water and sulphuric acid instead of over boiled mercury, which was used by the author. A re-determination of the vapour density of dried ammonium chloride by Dumas' method is published in the paper. When the bulb was protected from the outer air by a phosphorus pentoxide tube terminated by a long capillary, the density of 28.8 was obtained from the dried ammonium chloride, confirming the author's conclusion, based on six experiments by Victor Meyer's method, that dried ammonium chloride does not dissociate at 350°.

DISCUSSION.

Mr. SHENSTONE said he believed the precautions taken by Dr. Gutmann for preventing the access of water vapour to the dried ammonium chloride while determining its vapour density were insufficient, as Mr. Baker had shown; he had himself employed the very same precautions for a similar purpose in some of his earlier work on the production of ozone from oxygen, and though the results obtained were independently confirmed, and for some time accepted as correct, yet afterwards it became clear that the precautions in question had not really been sufficient for the purpose. Mr. Baker's explanation of the divergent results obtained by Dr. Gutmann and himself in their studies of the interactions of hydrochloric acid and ammonia, respectively, with phosphoric anhydride showed the importance of using pure phosphoric anhydride for such work, and he therefore ventured to draw attention to the fact that this substance cannot be prepared by merely redistilling the crude phosphoric anhydride. Certain precautions must be taken, *e.g.*, it is necessary to employ as low a temperature as is possible in order to avoid volatilising any metaphosphoric acid that may be present, and to seal up the product in glass tubes directly it is made.

The PRESIDENT said, in connection with Mr. Baker's results, it was interesting to remember that, in an elaborate paper in the *Phil. Trans.* for 1885, Professors Ramsay and Young detailed many

experiments proving that the statical and dynamical vapour pressures of ammonium chloride were identical, and that the vapour pressures found at about 330° compared with the vapour density of about 15 found by them, give a calculated latent heat which amounts to about 34650 gram units per molecule, or to about 80 per cent. of the theoretical value for complete dissociation. Mr. Baker obtained a normal vapour density at 350° , or about twice that of Ramsay and Young. Assuming the tensions of the vapour to be correct, and the density to be really double that found by Ramsay and Young, then the molecular latent heat would be reduced to about one-half of the value just mentioned. But can it be assumed that the tensions of the perfectly dry salt have been determined, or that they would be identical with the values already recorded? A series of such values with ammonium chloride completely free from water, together with vapour density determinations at lower pressures, would give most valuable results, and as the real interest of the research lay in this direction, he hoped the author would attack the problem.

***54. "Note on some of the properties of methylene di-iodide."**

By H. G. Madan, M.A.

Methylene di-iodide, CH_2I_2 , has for many years been used by mineralogists on account of its extremely high density (3.34 times that of water). This is, as usual, accompanied by a very high refractivity for light, which has been fully examined by Dr. Gladstone (*Trans.*, 1891, 59, 293), who found the index of refraction for yellow light (D) to be 1.756 at 10.5° , and the author has obtained nearly identical values with a different specimen. The coefficient of dispersion ($\mu_{\text{H}\gamma} - \mu_{\text{H}\alpha} = 0.062$) is decidedly higher than that of carbon disulphide, and, but for its doubtful permanency in light, methylene di-iodide might advantageously replace the latter substance in spectroscopy prisms, especially as its boiling point is very high (181°), and as it is practically non-inflammable. A few hours' exposure to strong sunlight turns it a light orange colour, and an exposure of 10 days deepens this to a red tint.

At a temperature of 100° , sulphur dissolves in methylene di-iodide fairly easily, but some crystallises out on cooling; enough, however, remains in solution at ordinary temperatures to raise the index for D to 1.778.

Methylene di-iodide dissolves phosphorus readily and abundantly; in fact, its own weight (or, taking into account the relative densities, about twice its volume) of phosphorus may be dissolved in it without reaching the point of saturation at ordinary temperatures. The resulting light yellow liquid has, as might be predicted, a very high refractivity, the index of refraction for the D line being 1.95 at 14° .

The third decimal place is not given, owing to a fact not readily explained, which was also noticed by Gladstone and Dale (*Phil. Mag.*, 1859, [iv], 18, 30) in dealing with solutions of phosphorus in carbon disulphide; viz., a difficulty in obtaining a sharp image of the spectrometer slit through the solution. The solution is, unfortunately, readily acted on by light, like similar solutions of phosphorus, a deposit of red phosphorus being formed.

This solution is far safer to deal with than the solution of phosphorus in carbon disulphide. A few drops poured on filter paper may be left freely exposed to the air for hours and even days without catching fire, the scarcely inflammable solvent seeming to form a kind of varnish over the phosphorus which protects the latter from rapid oxidation.

DISCUSSION.

MR. VERNON HARCOURT suggested that the presence of phosphorus in the methylene di-iodide might serve the incidental purpose of preventing the coloration of the liquid when exposed to light.

THE PRESIDENT asked if Mr. Madan had observed that the production of free iodine on exposure to light was in any way dependent on the presence of oxygen or traces of water. In the case of carbon disulphide, to which the author had referred as giving a deposit in prisms on exposure to light, this was certainly caused by a secondary action, which involved the presence of water, since perfectly dry carbon disulphide enclosed in sealed tubes, and exposed to sunlight, in presence of a dehydrating agent like sulphuric acid did not form any deposit.

MR. MADAN, in reply to Mr. Harcourt, said that he was afraid that the phosphorus did not seem to have the hoped-for result. In fact, the traces of iodine liberated appeared (as was noticed long ago by Sir B. C. Brodie, *Trans.*, 1853, 5, 289) to hasten the conversion of the phosphorus into the red allotropic form; and the solution, whether in a sealed tube or in an open watch-glass eventually solidified to an orange or red mass. In reply to the President, he said that the methylene di-iodide had been dried as far as possible by calcium chloride before being placed in the tubes for exposure to light, but he would take an early opportunity of ascertaining the result of a more careful and complete desiccation.

55. "The condensation of chloral hydrate with orcinol." By J. T. Hewitt, M.A., D.Sc., and F. Dixon, B.Sc.

The authors have reinvestigated the substance obtained by Michael and J. P. Ryder by the condensation of chloral hydrate and orcinol. The formula assigned to the substance by Michael and Ryder was

$C[C_6H_2(CH_3)(OH)_2]_3CH(OH)_2$. The authors find that on heating the aldehyde and phenol in aqueous solution at 100° for 16 hours a colourless product is obtained, which melts at $252-263^\circ$, and has the formula $C_{16}H_{16}O_6$. The molecular weight determined by raising the boiling point of an alcoholic solution was found to lie between 296 and 336. On heating in an atmosphere of coal gas, the acid loses a molecule of water and is converted into an almost colourless lactone having the formula $C_{16}H_{14}O_5$. A triacetyl-derivative of the lactone is formed by heating the acid with excess of acetic anhydride. This derivative is colourless and melts at 189° . On boiling the acid with excess of benzoyl chloride and pouring the hot solution into light petroleum, a tribenzoyl derivative of the lactone is obtained. The tribenzoate has the composition $C_{37}H_{26}O_8$, has no proper melting point, is apparently insoluble in water, alcohol, and light petroleum, and when allowed to remain in dilute alcohol for some time, is converted into a dibenzoate of the acid which melts at 204° , is readily soluble in alcohol, and has the formula $C_{30}H_{24}O_8$.

56. "Note on hexamethylene and its derivatives." By Emily C. Fortey, B.Sc.

In a preliminary note on hexanaphthene and its derivatives (*Proc.*, 1897, 13, 161) it was stated that this hydrocarbon had been obtained from American light petroleum in a state of partial purity, and its identity with hexamethylene was pointed out. It has since been obtained by means of fractional distillation from Galician petroleum. The purest fraction boils almost constantly at 81.75° , and has a specific gravity of 0.7899 at $0^\circ/0^\circ$. The following derivatives have been prepared. *Monochlorhexamethylene*, $C_6H_{11}Cl$, was obtained by passing a current of dry chlorine into the liquid for some hours. It is a colourless liquid boiling at $141.3-141.6^\circ$ under a pressure of 768 mm., and has a specific gravity of 0.9991 at $0^\circ/0^\circ$. *Dichlorhexamethylene*, $C_6H_{10}Cl_2$, was obtained together with mono- and a little tri-chlorhexamethylene by passing a rapid current of chlorine into heated hexamethylene. It is a colourless liquid when pure, but rapidly turns blue on exposure to air. It boils with slight decomposition at $194-195^\circ$ under atmospheric pressure. Both mono- and di-chlorhexamethylene give a deep red coloration on warming with concentrated sulphuric acid. On heating dichlorhexamethylene with quinoline a small quantity of a substance boiling between 80° and 90° is obtained, which appears to be dihydrobenzene. Its alcoholic solution gives a blue coloration with sulphuric acid (Baeyer, *Ber.*, 1893, 26, 230). Tetrahydrobenzene was obtained by heating monochlorhexamethylene with quinoline for 7 or 8 hours. It is a colourless liquid having the

properties described by Baeyer (*l. c.*), and boils at 82.3° under a pressure of 764 mm. *Monobromhexamethylene* could not be obtained by direct bromination of hexamethylene either with or without the aid of a bromine carrier. A small quantity was however prepared by the action of an aqueous solution of hydrobromic acid on tetrahydrobenzene. It is a colourless liquid which boils with slight decomposition at $162-163^{\circ}$. The present work will be continued with the view of preparing further derivatives of hexamethylene.

57. "The yellow colouring matter of the leaves of *Arctostaphylos uva ursi*." By A. G. Perkin.

Kawalier (*Jahr.*, 1852, 685) found the leaves to contain, besides gallic acid and arbutin, a glucoside ericolin, $C_{34}H_{56}O_{21}$, which yields on decomposition ericinol, $C_{10}H_{16}O$, and a sugar. More recently, B. Degraffe (*Am. Jour. Phar.*, 1896, 68, 313) has identified the tannin as gallotannin. There is also present a yellow colouring matter of the composition $C_{15}H_{10}O_7$, crystallising in glistening yellow needles; this forms an acetyl compound, $C_{13}H_5O_7Ac_5$, melting at $188-190^{\circ}$. On fusion with alkali, phloroglucinol and protocatechuic acid were formed. Though resembling quercetin in these points it has the property of forming deep green solutions with dilute potassium hydrate. Regarding this reaction as due to impurity, the colouring matter was converted (*a*) into a sulphate, and (*b*) into an acetyl-derivative, and the colouring matter regenerated from these, but in each case it was unaltered in its behaviour towards alkaline solutions. Oxidation in alkaline solution did not destroy the green coloration until complete decomposition of the colouring matter had taken place. The presence of ellagic acid has also been detected, and thus besides gallotannin, ellagitannin is also present. Broach leaves contain the same colouring matter.

58. "The yellow colouring matters of various adulterants of Sicilian sumach." Part V. By A. G. Perkin and P. J. Wood.

This paper describes an investigation of the leaves of those plants which are employed for the adulteration of Sicilian sumach (*Rhus coriaria*). We are indebted for samples of these to Mr. P. Gennadius, Director of Agriculture in Cyprus.

The leaves of *Pistacia lentiscus* (shinia) contain a colouring matter of the formula $C_{15}H_{10}O_8$, forming an acetyl compound, $C_{15}H_4O_8Ac_6$, crystallising in colourless needles (m. p. $204-206^{\circ}$). As on decomposition this yields gallic acid and phloroglucinol, it is identical with myricetin, the colouring matter of *Rhus coriaria*. Two tannins appear

to be present : one dissolves in ethylic acetate, yields gallic acid on decomposition, and is evidently gallotannic acid ; the other is insoluble, and forms acetic acid, phloroglucinol, and gallic acid on fusion with alkali. When digested with dilute sulphuric acid, the latter yields a red product resembling the anhydrides of the catechol tannins. The further examination of this tannin is reserved. *Shinia* leaves contain 11·3 per cent. of tannin, and appear to be a useful tanning agent, though not suitable for the same purposes as sumach.

The leaves and stems of *Tamaris gallica* and *T. africana* (bruca) contain the same colouring matter. It has the formula $C_{16}H_{12}O_7$, and forms an acetyl compound (m. p. 169—171°). Decomposition with alkali gave phloroglucinol and protocatechuic acid, and with hydriodic acid quercetin and a molecular proportion of methylic iodide were formed. This substance appears to be a new *methyl ether* of *quercetin*, distinguished from rhamnetin and isorhamnetin by its ready solubility in alcohol. So little of it was available for examination that its absolute purity could not be guaranteed. The tannin (8·4 per cent.) is evidently a mixture of ellagitannin and gallotannin, for both ellagic and gallic acids were isolated as its decomposition products.

The leaves of *Ailantus glandulosa*† contain quercetin. The tannin present (11·9 per cent.) is a mixture of ellagitannin and gallotannin, for both ellagic and gallic acids were isolated. This is a worthless tanning agent ; the skin though stained a deep colour is practically untanned.

The colouring matter of the leaves of *Ficus carica*, the common fig tree, though resembling quercetin, could not be identified, as from 2 kilos. only 0·08 gram of the substance was obtained. It is nearly devoid of tannin (analysis gave 1·6 per cent.), skin being untanned though stained a dirty olive colour.

Gambuzo, the stalks of the *Rhus coriaria*, contain a trace of myricetin and some gallotannic acid.

Broach leaves are employed in South Africa in place of sumach (*R. coriaria*), and are also replacing Cape sumach (*Colpoon compressum*) (*Trans.*, 1897, 71, 1132). They contain 19·9 per cent. of a catechol tannin, and they form a valuable tanning agent. The colouring matter, having the formula $C_{15}H_{10}O_7$, forms an acetyl compound, m. p. 188—190°, and on decomposition yields phloroglucinol and protocatechuic acid. It differs from quercetin in its reaction with dilute alkali forming deep green solutions, and appears to be identical with the colouring matter of *Arctostaphylos uva ursi* (see preceding abstract).

The galls of *Pistacia terebinthus* contain a trace of myricetin, whereas Mangrove cutch (*Cerriops candolleana*) is devoid of yellow colouring matter.

59. "The hydrolysis of starch by acids." By Harold Johnson.

It has been generally believed that the hydrolysis of starch by acids is similar in character to that effected by diastase, except that the maltose, which is the final product of the action of diastase, is transformed by acids into dextrose. An examination of the products of acid hydrolysis shows, however, that these are not identical with those of diastase conversion, and that when starch is hydrolysed by dilute acids there is neither production of amyloins (molecular aggregates of maltose and the amylin group) nor of maltose. The nature of the products resulting from the reaction can be shortly described as follows.

The cupric-reducing powers and specific rotations of the intermediate substances (fractionated by means of alcohol) as well as those of the total products of conversion, can be expressed exactly in values of dextrose and the amylin group. The relation between the specific rotation and the cupric-reducing power is constant throughout the whole of the reaction, and, given one of these values, the other may be calculated by the equation, $[\alpha]_{D_{386}}^{\circ} = 195 - (195 - 52.8)K_{386}/100$, in which α = the specific rotation, and K = the cupric-reducing power in terms of the percentage of dextrose.

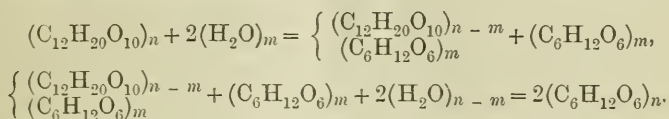
The specific rotations of the intermediate substances (separated from the dextrose by precipitation with alcohol) vary between $[\alpha]_{D_{386}}$ 80° and 190° . It should be remembered that the intermediate compounds in diastase conversions have rotations which vary from $[\alpha]_{D_{386}}$ 190° to 150° , so that the substances from the acid conversions with rotations which fall as low as 80° must differ in character from those obtained by diastase.

The behaviour of the intermediate substances from the acid conversions, when submitted to dialysis, shows that they are definite compounds, and not mixtures of dextrose and other carbohydrates, as, after purification, they dialyse without undergoing a change in specific rotatory power. Moreover, they are unfermentable in the presence of Saaz and Apiculatus yeasts. When treated with phenylhydrazine acetate, they yield gummy precipitates, and on further hydrolysis with acids are completely transformed into dextrose. Their solubility in alcohol decreases as their specific rotation increases.

The products of acid conversion also differ in a marked degree from those of diastase conversion when submitted to the action of diastase. The fall in specific rotation in the case of the products of acid conversion is extremely limited at any time during the reaction. Thus the action of diastase on an acid conversion whose rotation has fallen to $[\alpha]_{D_{386}}$ 115° is nil. At 140° the fall is 5° or 6° . At 170° the fall is

about 10^2 , the blue coloration produced by iodine disappearing at this point in the conversion under the influence of diastase. As, however, diastase has a slight degrading action on conversions which give no blue coloration with iodine, and have rotations between 140° and 115° , it is possible that an unreducing dextrin may be produced in the splitting up of the starch molecule; the slight fall in the rotation under the influence of diastase could then be explained by the degradation of this dextrin.

The action of dilute acids on starch can be expressed in its simplest form by the following equations,

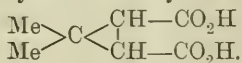


Taking into consideration their properties, the substances intermediate between starch and dextrose may be regarded as molecular aggregates of dextrose and the amylin group $(C_{12}H_{20}O_{10})_n$; the name *gluco-amylin*s will accurately describe them. Gluco-amylin with rotations of about $[\alpha]_{D^{25}} 80^\circ$ or 90° have been recognised in commercial glucose under the name of gallisin.

The formation of gluco-amylin by acid hydrolysis is thus explained: acids, being able to hydrolyse free maltose, exercise this action also on the maltose in molecular aggregates, and therefore amyloins at the moment of their formation would be transformed into dextrose and gluco-amylin. The molecule of starch is probably formed by the condensation of a large number of molecules of dextrose. In the first place, two molecules of dextrose condense to form maltose, and then a large number of maltose molecules further condense to form starch.

60. "Synthesis of cis- and trans-caronic acid." By W. H. Perkin, junr., and J. F. Thorpe.

The cis- and trans-modifications of caronic acid were obtained by Baeyer (*Ber.*, 1896, 29, 2796), by oxidising carone with alkaline permanganate, and as these acids when heated with hydrochloric acid yield terebinic acid, Baeyer concluded that they are the cis- and trans-forms of dimethyltrimethylenedicarboxylic acid,



The authors have succeeded in synthesising these acids in a manner which proves that they have the constitution assigned to them by Baeyer.

When the anhydride of $\beta\beta$ -dimethylglutaric acid is brominated

and the product poured into ethylic or methylic alcohol, the following ethereal salts are easily obtained. *Ethylic α -bromodimethylglutarate*, $\text{CO}_2\text{Et}\cdot\text{CHBr}\cdot\text{CMe}_2\cdot\text{CH}_2\cdot\text{CO}_2\text{Et}$, is a colourless liquid boiling constantly at 180° (30 mm.); the corresponding *methylic salt* distils at 155° (22 mm.). The *acid ethylic salt* of α -bromodimethylglutaric acid, $\text{CO}_2\text{H}\cdot\text{CHBr}\cdot\text{CMe}_2\cdot\text{CH}_2\cdot\text{CO}_2\text{Et}$, is a thick oil distilling without decomposition at 240° (35 mm.). *Methylic $\alpha\alpha'$ -dibromodimethylglutarate*, $\text{CO}_2\text{Me}\cdot\text{CHBr}\cdot\text{CMe}_2\cdot\text{CHBr}\cdot\text{CO}_2\text{Me}$, is a colourless, somewhat viscous liquid boiling at 172° (22 mm.). The methylic and ethylic salts of α -bromodimethylglutaric acid and the acid ethereal salt above described, yield, on treatment with alcoholic potash, a mixture of acids which melts at 180 — 200° , and consists of a mixture of the *cis*- and *trans*-modifications of caronic acid. The two modifications may be separated by taking advantage of the difference in solubility of their ammonium salts in hot alcohol, as suggested by Baeyer. The sparingly soluble ammonium salt yields *trans*-caronic acid, which crystallises from water in lustrous prisms melting at 212° . This acid gives a sparingly soluble crystalline silver salt, but does not form an anhydride. From the readily soluble ammonium salt, *cis*-caronic acid is obtained in plates melting at 174° , and yielding an anhydride melting at 54 — 56° . There can be no doubt that these acids are identical with the caronic acids prepared by Baeyer.

The authors are investigating the action of the bromo-ethereal salts described above on the sodium derivative of ethylic malonate.

61. "Preparation of solid ammonium cyanate." By James Walker and John K. Wood.

In connection with previous experiments on urea-formation (*Trans.*, 1895, 67, 746; 1897, 71, 489), it was thought desirable to make an attempt to prepare ammonium cyanate in the solid state. Liebig and Wöhler (*Ann. Phys. Chem.*, 1830, [ii], 20, 393), by passing the vapour of cyanic acid into dry ammonia, obtained a product which they held to be a basic ammonium cyanate. From the description of their experiments, it appears likely that what they actually had in their hands was the normal ammonium cyanate mixed with considerable quantities of urea and of cyamelide. The reason why they did not succeed in preparing the normal cyanate in the pure state is that the heat of combination of the ammonia and the cyanic acid is so great that, under the conditions chosen by them, a large proportion of the ammonium cyanate was decomposed, with formation of the above impurities and of ammonia. If this heating is avoided, it is a matter of no great difficulty to prepare the cyanate in a state which nearly approaches purity. A solution of ammonia in anhydrous ether is gradually added

to a solution of cyanic acid in anhydrous ether, both solutions being cooled to -20° . A gelatinous precipitate at once separates, which, after rapid filtration and removal of adhering ether, shrinks to friable masses of a pure white solid. If moisture is rigorously excluded during the operations, and the temperature never allowed to rise to the freezing point, the product is practically pure ammonium cyanate. When freshly prepared, it dissolves in water without residue, yielding a solution which is neutral to litmus. This proves that the product is free from cyamelide and ammonia, and the only impurity to be feared is urea. The substance effervesces on treatment with nitric acid, and no urea nitrate separates. Silver nitrate solution produces a white precipitate, which is soluble in boiling water and separates out on cooling, thus exhibiting the properties of silver cyanate. Portions of the salt on being analysed as soon after their preparation as possible gave the following numbers, the cyanate radicle being estimated as silver cyanate.

	Found.	Theory for ammonium cyanate.
NH ₄	30.0	30.0
CNO	70.9	70.0
N	46.8	46.7
C	19.8	20.0
H	7.0	6.7

The cyanate may be kept for a long time in closed tubes without undergoing any considerable alteration. Thus a portion which had remained at the ordinary temperature for fourteen days still contained over 95 per cent. of cyanate. On heating in a melting point capillary, the cyanate contracts visibly at a temperature somewhat above 60° and melts suddenly at a temperature varying between 76° and 89° , according as the heating is conducted rapidly or not, and according to the tightness with which the material is packed. The fused mass, however, immediately solidifies, and does not again melt till a temperature of 128° is reached—urea melting at 132° . A minute quantity of gas is given off during the first fusion, and a litmus paper introduced into the upper part of the tube is then turned blue. When the experiment is made on a larger scale, a smell of ammonia is perceptible. Corresponding to this liberation of ammonia, it is found that the transformed solid is not entirely soluble in water, a slight flocculent residue of cyamelide remaining. The first fusion observed when the substance is heated doubtless results from the rapid transformation of cyanate into urea, enough heat being evolved to liquefy the urea produced, which thereafter cools to a temperature below its melting point. The contraction at first observed probably indicates the temperature at which the transformation proceeds at a perceptible rate. After 5 hours at

61°, a portion of the cyanate was found to be almost wholly transformed into urea, a small quantity of ammonia and cyamelide being formed at the same time. Twenty hours' heating at 43° effected the transformation of only 28 per cent. of the cyanate. On opening the tube, it was again found that ammonia had been produced, and that the residue was not completely soluble in boiling water. The transformation of the solid cyanate into urea seems, therefore, to be always accompanied by a subsidiary transformation into cyamelide and ammonia.

The investigation is being continued with a view to determining the accurate temperature of transformation of the cyanate, if this is possible, and also to effect the preparation of alkyl ammonium cyanates by similar means.

62. "The chlorine derivatives of pyridine. Part I." By William J. Sell, M.A., F.I.C., and F. W. Dootson, M.A.

The authors have examined the action of phosphorus pentachloride on pyridine, and have isolated the following compounds. (1) A dichloropyridine, m. p. 87—88°; (2) a trichloropyridine, m. p. 49—50°; (3) a trichloropyridine, m. p. 71—72°; (4) a trichloropyridine, m. p. 67—68°; (5) a tetrachloropyridine, m. p. 90—91°; (6) a tetrachloropyridine, m. p. 21—22°; (7) a tetrachloropyridine, m. p. 74—75°; (8) pentachloropyridine, m. p. 123—124°.

63. "Simple experimental illustration of the law of multiples." By A. Wentworth Jones, M.A.

Calculated quantities—for example, four times the milligram-molecules—of potassium chlorate and perchlorate are weighed into hard glass tubes provided with corks and delivery tubes, each passing by india-rubber connections through the hole in a beehive-shelf, to near the top of a graduated gas jar full of water in the pneumatic trough. After heating the tubes in the full bunsen flame for a few minutes, gas ceases to come off, the flames are removed, and the tubes allowed to cool and to withdraw their original content of gas from the receivers through the upturned delivery tubes. The relative volumes collected stand, of course, in the proportion 3:4 for equal weights of residue in the tubes. In an experiment before a class, the volumes obtained were 146 and 194 c.c., *i.e.*, in the proportion of 3:4 almost exactly. After weighing tubes and residues, and then cleaning and weighing the tubes, the difference or weight of residue was, in each case, 0.30 gram.

64. "Lauronolic acid." By R. W. Collinson and W. H. Perkin, junr.

In connection with the experiments made by one of the authors on isolauronolic acid, they have lately examined lauronolic acid with the following results.

Lauronolic acid is not reduced by sodium amalgam, but when treated with hydrobromic acid is converted into a hydrobromide, $C_9H_{15}O_2Br$, which melts at about 133° with decomposition, and when treated with bromine in chloroform solution, yields a substance which melts at 185° and seems to have the composition $C_9H_{13}O_2Br$.

Boiling with dilute nitric acid converts lauronolic acid into a substance of the formula $C_9H_{13}(NO_2)O_2$, which is volatile in steam, and melts at 170° .

When a cold solution of the sodium salt of lauronolic acid is oxidised with potassium permanganate, a syrupy acid of the formula $C_9H_{14}O_5$ is produced, which is at present under investigation.

Lauronolic acid, when warmed with sulphuric acid at $30-40^\circ$, is completely decomposed, carbon monoxide being formed together with substances which so far have not been investigated.

65. "The action of aluminium chloride on camphoric anhydride."

By Frederic H. Lees and W. H. Perkin, junr.

In the course of experiments on isolauronolic acid, on which one of the authors has been engaged for some years, an attempt was made to prepare this acid by a method described by G. Blanc (*C. R.*, 1896, 123, 749—752, *Bull. Soc. Chim.*, 1896, [iii], 15, 1191—1199), which consists in acting on a solution of camphoric anhydride in chloroform with aluminium chloride. For a long time the authors failed to obtain anything like the yield of isolauronolic acid obtained in this way by Blanc (40 per cent.), and on investigating the cause of this discrepancy, they have isolated the following new substances as products of the reaction. (1) A *neutral oil* corresponding to about 30—40 per cent. of the camphoric anhydride employed. This substance, which the authors propose to call *ψ-campholactone*, boils constantly at $163-164^\circ$ (50 mm.), has the formula $C_9H_{14}O_2$, and is isomeric with lauronolic acid, isolauronolic acid and campholactone. It is converted by treatment with potash into the corresponding hydroxy-acid, $C_8H_{14}(OH)CO_2H$, a thick syrup which readily loses water, reforming the lactone. When *ψ-campholactone* is heated with concentrated sulphuric acid at 90° , sulphur dioxide is evolved, and on adding water a crystalline acid is precipitated in quantity; this melts at 126° , and proves to be xylic acid, $C_6H_3Me_2CO_2H$ (1 : 3 : 4).

(2) An *acid* melting at $255-257^\circ$, which gives numbers on analysis agreeing with the formula $C_{11}H_{16}O_3$.

The authors are engaged in the examination of this acid and of ψ -campholactone, as they hope in this way to obtain results having a direct bearing on the constitution of camphoric acid.

66. "On the action of bromacetal on the sodium derivative of ethylic malonate." By W. H. Perkin, junr., and C. H. G. Sprankling.

For some months the authors have been engaged in the examination of this decomposition, and although their experiments are far from complete, they wish to give a short account of the results as yet obtained, in view of a recent paper by Harries (*Ber.*, 1898, 31, 37), which deals with substances somewhat similar to those obtained by them.

Bromacetal has little action on the sodium derivative of ethylic malonate at 100° , but when these substances are heated at 140 — 150° in sealed tubes, interaction takes place readily with the formation of ethylic acetalmalonate.

Ethylic acetalmalonate, $(\text{CO}_2\text{Et})_2\text{CH}\cdot\text{CH}_2\cdot\text{CH}(\text{OEt})_2$, boils constantly at 151 — 154° (15 mm.), and on hydrolysis with alcoholic potash yields the corresponding *acetalmalonic acid*, $(\text{CO}_2\text{H})_2\text{CH}\cdot\text{CH}_2\cdot\text{CH}(\text{OEt})_2$, a colourless syrup, which when heated with water at 190° is decomposed with elimination of carbon dioxide and alcohol, and formation of a substance, which is apparently the half aldehyde of succinic acid, $\text{CO}_2\text{H}\cdot\text{CH}_2\cdot\text{CH}_2\cdot\text{CHO}$. This is a colourless syrup, which on long standing deposits crystals, reduces Fehling's solution, combines with phenylhydrazine, and yields succinic acid on oxidation with nitric acid.

The authors are investigating these substances, as well as the action of bromacetal on the sodium derivatives of other ethereal salts.

67. "The sulphonation of benzophenone and of diphenylmethane." By Arthur Lapworth, D.Sc.

Benzophenone, as it contains the group $-\text{CO}-$ in direct attachment to the benzene nucleus, should afford a considerable quantity of meta-acid on sulphonation. It has long been supposed that the major portion of the product was the para-disulphonic acid, as Städel obtained parahydroxybenzoic acid on fusing it with alkali (*Ann.*, 1878, 194, 134). The author has been unable to confirm Städel's observation; the disulphonic acid he obtained by sulphonation yielded almost pure metahydroxybenzoic acid on fusion with alkali, and there is therefore, no reason to regard the behaviour of benzophenone on sulphonation as exceptional. During the investigation the following substances were obtained and characterised. Benzophenonedisulphonic chloride, $\text{C}_{13}\text{H}_8\text{O}(\text{SO}_2\text{Cl})_2$, crystallises from chloroform in large, anorthic plates melting at 138° , and the form, described by Beckmann, melting

at 121.5° could not be obtained. The *amide* forms needles melting at 157° , and the *anilide* large crystals melting at 177 — 178° . The *piperidide* crystallises in monoclinic prisms or plates melting at 168° , and has the curious property of forming a transparent jelly when its alcoholic solution is slowly cooled. A brief study of the sulphonation products of diphenylmethane was made. They appear to be a mixture of disulphonic acids, of which one, doubtless the dipara-acid, yields a *chloride*, $C_{13}H_{10}(SO_2Cl)_2$, melting at 124° , an *anilide* melting at 178° , and a *piperidide* melting at 171 — 172° . When the sulphonation is carried out by means of chlorosulphonic acid, *diphenylmethaneortho-sulphone*, $C_{13}H_{10}SO_2$, is also produced; its constitution follows from the fact that, when oxidised, it yields the benzophenonesulphone described by Städel, the structure of which has been determined.

68. "The separation of optical isomerides." By Frederic Stanley Kipping and William Jackson Pope.

In a previous paper ("Racemism and Pseudoracemism," *Trans.*, 1897, 71, 989), the authors have dealt with a number of the properties of optically active compounds and their externally compensated isomerides. It would seem, however, that much may be learnt respecting the mutual relationships of these substances by a study of their respective behaviour towards solvents which are themselves optically active. In this preliminary note, the authors record the results obtained up to the present in some experiments on the separation of a mixture of equal quantities of enantiomorphously related substances by crystallisation from optically active solvents. The first attempts which the authors made to effect such a separation were unsuccessful; inactive mandelic acid, for instance, crystallised unchanged from an aqueous solution of dextrose. Since, however, inactive mandelic acid is a well-defined racemic compound at ordinary temperatures, it might well be that the tendency to form a solid racemic compound would overcome any tendency towards separation due to the presence in the system of a third enantiomorphous substance; the authors were therefore led to attempt the separation of an externally compensated mixture of two substances which do not form a solid racemic compound at the temperature employed. These experiments were successful.

An externally compensated mixture of sodium ammonium dextro- and lævo-tartrate forms a solid racemic compound only above 27° , and when crystallised from water at ordinary temperatures crystals of the dextro- and lævo-isomerides separate in equal quantities side by side, and may be mechanically separated. The authors find, however, that when an optically inactive mixture of sodium ammonium dextro- and lævo-tartrates is dissolved in a concentrated aqueous solution of dextrose, and crystallisation allowed to take place spontaneously at ordinary

temperatures (below 27°), the crystalline deposit which first separates contains a very considerable excess of the dextrorotatory salt; when freed from dextrose, first by recrystallisation from water at ordinary temperatures, and then by fractional precipitation from a warm aqueous solution by alcohol, this first deposit yields a quantity of sodium ammonium tartrate having a high specific dextrorotation. Eleven samples of salt, each obtained from a different solution, have so far been examined; in only one case the salt separated by the method just described was optically inactive, whilst in all the others it was dextrorotatory. Full quantitative details will be published later, but to afford some idea of the extent to which separation occurs, the authors find that from 175 grams of a crystallised optically inactive mixture of sodium ammonium dextro- and lævo-tartrates, treated as above in six separate and approximately equal portions, they obtained the following six samples of hydrated active salt.

	1	2	3	4	5	6
Weight in grams.	3.2	3.8	3.0	3.7	4.2	3.5
$[\alpha]_D$	+15.50°	+22.07°	+22.97°	+23.30°	+20.65°	+10.56°

Landolt's value for the specific rotation of sodium ammonium dextro-tartrate calculated on the hydrated salt is $[\alpha]_D = 23.70^{\circ}$. The authors have satisfied themselves that all the samples examined in the polarimeter were free from dextrose, and that the racemic acid used in making the salt was optically inactive. The results thus briefly recorded seem to show that enantiomorphously related substances are not equally soluble in presence of a third enantiomorphous substance; whether the difference under these conditions will be sufficient in all cases to render a separation of the two isomerides possible, thus adding another to the few methods by which this may be accomplished, is a matter which is still under investigation.

At the next meeting, on Thursday, May 5th, the following papers will be communicated by the authors.

"The reactions of the carbohydrates with hydrogen peroxide." By C. F. Cross, E. J. Bevan, and Claud Smith.

"The properties and relationships of dihydroxytartaric acid. Part II." By H. J. H. Fenton, M.A.

"The affinity constants of certain hydroxy-acids." By S. Skinner, M.A.

"Molecular weights in solution of permanganates, perchlorates, and periodates." By J. Murray Crofts, B.A., B.Sc.

PROCEEDINGS
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No. 194.

Session 1897-8.

May 5th, 1898. Professor Dewar, F.R.S., President, in the Chair.

Messrs. E. C. Jee, W. Marshall, and T. H. Pope were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. Harry Brearley, Totley, Derbyshire; Arthur Stanley Hemmy, Government College, Lahore; Leonard Myddleton Nash, 281, Seven Sisters' Road; Finsbury Park, N.; Edward John Russell, Owens College, Manchester; Sigmund Stein, 323, Vauxhall Road, Liverpool; Frank Edwin Weston, 43, Larkhall Rise, Clapham, S.W.; William Williamson, 86, Tyndall Road, Leyton, E.; Charles Arthur Wrench, 3, Parklands, Surbiton Hill.

Of the following papers those marked * were read:—

*69. "The action of hydrogen peroxide on carbohydrates in the presence of iron." By C. F. Cross, E. J. Bevan, and Claude Smith.

The results obtained by H. J. H. Fenton (*Trans.*, 1894, 65, 899; 1895, 67, 48; 1896, 69, 546) in oxidising tartaric acid by hydrogen peroxide in presence of soluble iron compounds suggested the application of the method to other hydroxy-compounds, and notably to the carbohydrates. The authors have studied the behaviour of typical hexoses and of cane-sugar, when treated in aqueous solution with hydrogen peroxide at ordinary temperatures, and, in confirmation of Fenton's observations, have found in this group also that the presence of iron compounds is an essential condition for the production of the characteristic reactions. A convenient proportion of iron (Fe as

$\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$) is 1/10000 of the weight of a solution containing 4 grams of the carbohydrate in 100 c.c. The authors reserve for the present any statement of the limiting proportion which may be necessary, and are engaged in ascertaining whether other inorganic compounds may not be found to have similar effects.

With such proportions and with hydrogen peroxide in quantities sufficient to supply 1 or 2 atoms of oxidising oxygen for each molecule of hexose, reaction takes place readily with marked rise of temperature ($10-20^\circ$), but in the absence of iron compounds, all other conditions remaining the same, nothing happens at ordinary temperatures. After reaction, the solutions are acid to the taste. The quantity of acid formed is greater from dextrose than from lævulose. The volatile acids separated by distillation are formic and acetic acids, and represent 15—20 per cent. and 4—7 per cent. respectively of the weight of the dextrose. The non-volatile acids represent about one-half the total acidity, and contain a dicarboxylic acid which is easily isolated by precipitation as lead salt in the presence of acetic acid, and on analysis gives numbers corresponding with those required for tartronic acid.

After removal of the acids, the presence of furfuroids is identified by estimations of furfural in the distillates from hydrochloric acid (sp. gr. 1.08). The quantities obtained from dextrose or cane-sugar are 3—4 per cent., representing 7—9 per cent. of the furfuroid. The products yielding furfural are not acid in character, but there is no evidence that they are pentoses. From lævulose, only traces of these products are formed. The solutions give a well-marked iodoform reaction, indicating that the hexose molecules undergo internal rearrangement, and that the phenomena are not those of a simple oxidation.

The characteristic products of the reaction are separated from solution by the addition of alcohol and ether; on drawing off the denser aqueous layer, a solution is obtained which dries in a vacuum to a gummy solid, destitute of any appearance of crystallisation. These compounds react with phenylhydrazine acetate in the cold, forming osazones, and give evidence of the presence of highly reactive groups by reducing Fehling's solution in the cold. The yield of osazones is considerable, amounting to 30—60 per cent. of the weight of the carbohydrate in the case of lævulose and of cane-sugar; and to 12—20 per cent. in that of dextrose. Two groups of osazones have been obtained, (1) compounds melting at $185-195^\circ$ and resembling the glucosazones in properties, but differing from them in composition, the nitrogen ($\text{N} = 17-20$ per cent.) being 2—3 per cent. higher; (2) compounds with a low melting point (130°), and freely soluble in hot water. From these results, it might be inferred that the products are the

"osones" or "oxyglucoses" of Fischer, but they resist the action of zinc and acetic acid on the one hand, and of bromine on the other, and are not reduced by sodium amalgam in solutions kept slightly acid; properties which differentiate them from the normal carbohydrates and from such of their oxy-derivatives (ketaldoses) as are at present known.

The investigation of the nature of these products is complicated by the fact that no crystalline derivatives other than the osazones have been obtained. No definite acetates or benzoates have been isolated. Some evidence as to their relationship to the original hexoses, however, is obtainable from a closer study of the constants of the reaction. It appears, in the first place, that there is no simple proportion between the quantity of hydrogen peroxide employed and the amount of the characteristic products obtained. Having established this for quantities representing 3, 2, and 1 atom of oxygen for each molecule of the hexose, the authors found that very considerable effects were still produced on further reducing the proportion of peroxide. Thus from 40 grams dextrose treated with sufficient peroxide to furnish only 1/10 atom of oxygen for each molecule of hexose, the quantity of osazones formed in the cold from the product of the reaction was 8 grams, an amount as great, therefore, as that obtained when 10 times this proportion of the peroxide was employed. Similarly, the addition of still smaller quantities of the peroxide to a dextrose solution was found to convert a considerable proportion of the hexose into compounds not fermented by yeast, though reducing Fehling's solution and otherwise resembling the compounds just described.

The authors conclude (1), that hydrogen peroxide acts primarily by determining a constitutional change in the hexose molecule, *i.e.*, by internal rearrangement, such effects bearing no direct proportion to the quantity added, and (2), that the oxidising actions observed, *e.g.*, the formation of dicarboxylic acids, are subordinate or secondary effects.

As regards the nature of the constitutional changes in question, the reactions of the characteristic products indicate the presence of $-C(OH):C(OH)-$ groups. In the formation of dihydroxymaleic acid from tartaric acid, this radicle results from an actual removal of hydrogen by oxidation, and in the carbohydrates might be formed by internal rearrangement. The authors consider that such a change is the primary effect of contact with the peroxide, although $-CH(OH)\cdot CH(OH)-$ residues also are probably attacked and hydrogen eliminated by direct oxidation.

The obvious bearings of these results upon the problem of plant physiology, from which point of view they are positive and sufficiently

established, induce the authors to put forward this preliminary communication without waiting for a definite solution of the constitutional problems, which are still under investigation.

DISCUSSION.

Dr. ARMSTRONG referred to the interest of the work in connection with vegetable physiology, indicative as it was of the far-reaching character of the interactions concerned in the elaboration of the products of plant activity. Although the part played by enzymes in such processes had been generally recognised, their importance must be much accentuated now that Buchner's remarkable discovery of an enzyme capable of inciting alcoholic fermentation was placed beyond doubt. It seemed quite possible, from the experiments of Mr. Cross and his colleagues, that iron, which is known to be present in most plants, may behave to some extent as an enzyme and thus possess unexpected importance from the point of view of plant chemistry; it was very noteworthy from this point of view that the formation of reduction products yielding iodoform had been observed as well as that of oxidation products.

Dr. MORRELL stated that, with galactose, the disappearance of hydrogen peroxide is twice as rapid as with glucose, and that the addition of large quantities of the peroxide caused a marked rise of temperature. Ferrous iron, which could not be detected during the oxidation, reappeared when hydrogen peroxide could be recognised no longer in the solution.

Mr. FENTON said that, since he had observed the peculiar influence of iron in the oxidation of tartaric acid, experiments had been made in other directions, and as so wide a field had been opened up for investigation the co-operation of the authors and of Dr. Morrell was most welcome.

Mr. LING, referring to the possible analogy between the products of the reaction described by the authors and those formed by the oxidation of sugars by alkaline copper solutions, said that Kjeldahl had observed that glucose and fructose, when boiled with a solution of potassio-copper sulphate (Ost's solution), yield mesoxalic acid. Kjeldahl had also shown that this acid, on treatment with phenylhydrazine acetate, is converted into a dihydrazide melting at 148° ,—a derivative, therefore, of dihydroxymalonic acid. Might not the supposed osazone, which was formed in the cold, be a substance of this kind?

Mr. CROSS, in reply, stated that the phenylhydrazine derivatives obtained in the cold had the characteristics of osazones, although

neither aniline nor ammonia, which according to Fischer are simultaneously produced in the osazone reaction, could be detected in the filtrates. It had not escaped attention that the derivatives might possibly be hydrazides resulting from condensation with a -C(OH):C(OH)- group, and they were being investigated from this point of view.

***70. "Note on the oxidation of certain acids in presence of iron."**
By Henry J. Horstman Fenton, M.A.

It has been shown in several previous communications (*Trans.*, 1894, 65, 899; *B. A. Report*, 1895, &c.) that when tartaric acid is oxidised in presence of a small quantity of ferrous iron, one molecule of the acid loses two atoms of hydrogen, giving rise to dihydroxymaleic acid. The most effective oxidising agent for the purpose is hydrogen dioxide, but the result is also brought about by chlorine, hypochlorites, bromine, &c., and by atmospheric oxygen in presence of sunlight. The presence of ferrous iron is essential, but its proportion seems to bear but little relation to the yield of acid in the ordinary course of preparation, the action being, in fact, what is usually termed catalytic. It is necessary that the addition of iron shall precede that of the oxidising agent. From the fact that dihydroxymaleic acid, on heating with water, yields glycollic aldehyde, and that this readily condenses to a hexose, it is evident that the change may afford information with regard to the natural formation of carbohydrates.

The production of dihydroxymaleic acid from tartaric acid is most easily represented by assuming the removal of the two non-hydroxylic hydrogen atoms: $\text{C}_2\text{H}_2(\text{OH})_2(\text{CO}_2\text{H})_2 - \text{H}_2 = \text{C}_2(\text{OH})_2(\text{CO}_2\text{H})_2$. It is true that dextrotartaric acid would be expected, in this manner, to yield a fumaroid instead of a maleoid acid; but it is quite possible that 'stereomeric' change takes place during one of the stages of preparation, and in any case this objection can hardly be considered a serious one, bearing in mind the large number of known exceptions (*Michael, J. prakt. Chem.*, 1892, 46, 400).

While seeking for a chemical explanation of the part played by the iron, the following may be offered as a provisional suggestion. The two non-hydroxylic hydrogen atoms in tartaric acid may be supposed to possess feebly acid functions owing to the neighbourhood of the $\text{CO}_2\text{H-}$ and OH- groups, and it is possible that an atom of divalent iron may replace these two hydrogen atoms, giving the compound:

$\text{CO}_2\text{H}\cdot\text{C}(\text{OH})\langle\text{Fe}\rangle\text{C}(\text{OH})\cdot\text{CO}_2\text{H}$. On addition of the oxidising agent

the iron atom assumes the trivalent state, and can therefore no longer be 'retained.' The result is an unsaturated acid, and the iron enters into solution as a ferric salt, *e.g.*, ferric tartrate. Dihydroxymaleic

acid readily reduces ferric salts in the cold, experiment indicating that two atoms of iron are reduced by one molecule of the acid, so that the ferrous iron is regenerated at the expense of a portion of the acid.

A large number of the commoner acids have been investigated as regards their behaviour in this respect. In addition to all the non-hydroxylic acids examined, lactic, malic, citric, and tartronic acids give negative results. If, however, the above explanation be accepted, it is evident that the production of the violet coloration would only be expected in the case of those acids the molecules of which contain at least two $\text{CH}(\text{OH})-$ groups. Mucic and saccharic acids might therefore be expected to yield positive results, and recent experiments have shown that this is the case. Both these acids, when treated in the cold with a limited quantity of hydrogen dioxide in presence of ferrous iron, give intense violet colorations. Attempts are being made to isolate the oxidation products, which appear to be even less stable, however, than dihydroxymaleic acid.

DISCUSSION.

Dr. ARMSTRONG thought a more probable explanation of the part played by iron to be that the iron salt became added to the carboxylic group; if changes then occurred such as he had suggested take place when optical inversion is effected by hydrolytic agents (*Trans.*, 1896, 69, 1399), it would be easy to understand why dihydroxymaleic acid was obtained instead of the fumaric derivative.

Mr. FENTON, referring to the suggestion he had made, said that replacement of non-hydroxylic hydrogen atoms by metals might also occur in Fehling's and other similar solutions. In experiments with equal molecular quantities of dihydroxytartrates and tartrates, it had been found that the power of retaining copper in solution in the presence of alkali is very much greater in the latter case, although the reverse might be expected if replacement occurs in the alcoholic hydroxyl groups as is commonly supposed.

*71. "Properties and relationships of dihydroxytartaric acid. Part II. Metallic Salts." By Henry J. Horstman Fenton, M.A.

The only metallic dihydroxytartrate which appears to have been prepared and studied is the sodium salt—the supposed barium salt being probably a mixture. Several other salts of the acid are now described. It is shown that the solubilities of the normal salts of sodium, potassium, rubidium, and cæsium increase with the rise in atomic weight of the metal. The lithium salt is exceptional, its solubility being greater than that of the sodium salt. The differences

in solubility of these salts may perhaps be of service in separating the metals of the alkalis.

Solutions of soluble dihydroxytartrates act as powerful reducing agents towards salts of silver, copper, and mercury, but are themselves reduced to dihydroxymaleic acid by stannous and ferrous salts.

***72. "The affinity-constants of dihydroxymaleic, dihydroxyfumaric, dihydroxytartaric, and tartronic acids." By S. Skinner, M.A.**

The affinity-constants have been determined from the conductivity of the aqueous solutions. The determination in the case of these acids, with the exception of tartronic acid, presents special difficulty as their solutions undergo gradual decomposition. The constants found are compared with those of malonic, succinic, fumaric, maleic, and tartaric acids, and it is shown that an increase in the value of the constant occurs:—(1) on the introduction of hydroxyl groups; (2) for the lower members of the series of dibasic acids; (3) for the unsaturated acids as compared with their saturated isologues.

DISCUSSION.

Dr. WALLACE WALKER objected to the explanation given of the nature of the curves on the ground that in the production of carbon dioxide and glycollic aldehyde from dihydroxymaleic acid, the concentration of the supposed catalyser is decreasing at the same rate as that of the negative ion. The reaction would therefore be bimolecular, and its curve not rectilinear but one represented by an equation of the second degree.

Mr. FENTON asked whether the results obtained with dihydroxymaleic acid could be explained by the suggestion, advanced in a previous communication, that combination with a molecular proportion of water occurs on dissolution with the production of the unstable trihydroxy-succinic acid.

Mr. SKINNER, in reply, recognised that explanations of the behaviour of dihydroxymaleic acid other than that adopted in the paper were possible, but he was not prepared to say how far they would be of assistance in elucidating the results of the conductivity experiments.

***73. "Note on the enolic and ketonic forms of ethylic acetoacetate." By R. S. Morrell, M.A., Ph.D., and J. M. Crofts, B.A., B.Sc.**

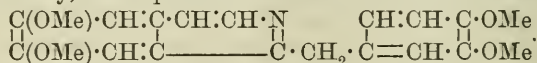
The authors find that the purple oil obtained by the action of anhydrous ferric chloride on ethylic acetoacetate is decomposed by water in the presence of ether into ferric chloride and the ketonic

ethereal salt. The ether is found to contain the ketonic and not the enolic form, as would be expected. To identify the ketonic form, the method given by Schiff and Bertini (*Ber.*, 1898, 31, 207) is employed. The ethylic benzalanilineacetoacetate is found to have the composition, melting point (78°), and properties of the ketonic form. The tautomeric change is probably due to the fact that the ferric chloride compound of ethylic acetoacetate, when decomposed by water in the presence of ether, produces hydrochloric acid, which converts the enolic into the ketonic form.

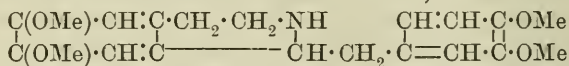
The authors mentioned in a previous paper that ethylic benzaldiacetoacetate formed a purple oil with ferric chloride in benzene solution, whereas, in alcoholic solution, there was no such coloration. This oil has been obtained in the solid form and is being investigated on the lines just indicated for the ethylic acetoacetate compound.

*74. "The resolution of tetrahydropapaverine into its optically active components." By William Jackson Pope and Stanley John Peachey.

Goldschmiedt has shown that papaverine is optically inactive and is, in all probability, an isoquinoline derivative of the constitution



This formula does not contain an asymmetric carbon atom and, up to the present, no optically active derivative of papaverine has been described. Amongst the derivatives of papaverine prepared by Goldschmiedt (*Monats.*, 1886, 7, 495) is a tetrahydropapaverine, $\text{C}_{20}\text{H}_{25}\text{NO}_4$, to which, on the basis of the above constitution, the formula



must be assigned, since, on reducing isoquinoline derivatives, hydrogenation takes place in the pyridine nucleus. On this assumption, tetrahydropapaverine contains an asymmetric carbon atom, and it should therefore be possible to separate the optically inactive compound into two enantiomorphously related isomerides, and thus obtain evidence confirming the constitution which Goldschmiedt has assigned to papaverine.

In 'splitting' an externally compensated base into its enantiomorphously related components, the dextrotartrate is almost invariably employed; it would seem preferable, however, on various grounds, to make use in such cases of the dextrobromocamphorsulphonic acid described by Kipping and Pope (*Trans.*, 1893, 63, 584). Dextrobromocamphorsulphonic acid is a far more powerful acid than tartaric acid, and hence might be expected to yield better characterised and more

easily isolated salts than the latter, with the further advantage that with a monobasic acid there is usually no tendency to form two classes of salts. Dextrobromocamphorsulphonic acid is conveniently prepared from the ammonium salt by conversion into the barium salt and careful precipitation of the solution by sulphuric acid. After filtration, the strength of the resulting solution is determined by titration.

Tetrahydropapaverine is boiled with rather more than the calculated quantity of dextrobromocamphorsulphonic acid dissolved in a large quantity of water. Ultimately, the whole dissolves, and, on cooling, long needles of lævotetrahydropapaverine dextrobromocamphorsulphonate, $C_{20}H_{25}NO_4 \cdot C_{10}H_{14}BrO \cdot SO_3H$, crystallise out. Further quantities of this salt are obtained, mixed with increasing quantities of the more soluble dextrotetrahydropapaverine dextrobromocamphorsulphonate, on concentrating the mother liquors. The two salts are readily separated by crystallisation from boiling water.

Lævotetrahydropapaverine dextrobromocamphorsulphonate crystallises readily from water, in which it is sparingly soluble in the cold, in long, colourless, anhydrous needles melting with decomposition at $295-298^\circ$; it is somewhat more soluble in absolute alcohol, but insoluble in most other organic solvents. In a 0.3 per cent. absolute alcoholic solution, it has the specific rotation of about $[\alpha]_D = -30^\circ$.

Dextrotetrahydropapaverine dextrobromocamphorsulphonate separates from solution as a resin which could not be obtained crystalline; when purified by repeated separation from its boiling aqueous solution and dried in the air, it forms a gritty, amorphous powder.

Lævotetrahydropapaverine, $C_{20}H_{25}NO_4$, separates on cooling a hot aqueous solution of its dextrobromocamphorsulphonate to which excess of ammonia has been added; it crystallises from boiling dilute alcohol in colourless, minute, six-sided plates containing water which melt at 223° . The large flat face of the crystal is perpendicular to the acute bisectrix of a very small axial angle and of negative double refraction; the material has the specific rotation $[\alpha]_D = -149.5^\circ$ in a chloroform solution containing 0.7987 grams per 25 c.c. The *dextrotetrahydropapaverine* separated from its dextrobromocamphorsulphonate resembles the lævo-isomeride in all respects, but is of opposite rotation.

Inactive tetrahydropapaverine melts at $200-201^\circ$, and at ordinary temperatures is crystallographically different from its optically active components; it is, therefore, a racemic compound in the sense of Kipping and Pope's definition (*Trans.*, 1897, 71, 989). It is formed on crystallising a mixture of equal weights of the two optically active isomerides from dilute alcohol.

The salts of racemic, dextro- and lævo-tetrahydropapaverine are being investigated, and experiments on other optically inactive alkaloids and their reduction products are in progress.

75. "Molecular weights of permanganates, perchlorates, and periodates in solution." By J. Murray Crofts, B.A., B.Sc.

The molecular weight of potassium permanganate in solution has been determined only by the specific conductivity method. In view of the close relationship between manganese and chlorine indicated by the periodic classification of the elements, it was thought that further investigation of the molecular weights of these substances in solution would be of interest.

The method adopted was that devised by Löwenherz (*Zeit. physik. Chem.*, 1895, 18, 70), in which Glauber's salt is the solvent employed. In this solvent sodium salts cannot undergo dissociation. The methods by which practically pure crystalline sodium permanganate and the very deliquescent sodium perchlorate were obtained are described. Determinations with both the sodium and the potassium salts of the acids were made, and the results point to the formula $M'MnO_4$ for permanganates, and $M'ClO_4$ for perchlorates. For periodates (meta-periodates) the potassium salt only was used, and the constant obtained indicated KIO_4 as the formula.

The results afford additional evidence for the inclusion of manganese with the halogens in group VII. of the periodic classification. The author is inclined to advocate Spring's formula for perchloric acid (*Bull. Acad. Belg.*, [ii], 39, 887), and a corresponding expression for permanganic acid, the chlorine and manganese atoms being regarded as heptavalent in these compounds.

76. "The action of chlorine on pyridine." By W. J. Sell, M.A., F.I.C., and F. W. Dootson, M.A.

In this communication the results are given of a repetition, in part, of the work of Keiser (*Am. Chem. J.*, 1886, 8, 308), undertaken primarily with the object of comparing his dichloropyridine hydrochloride with the trichloropyridine, melting at $71-72^\circ$, obtained by the authors by the action of phosphorus pentachloride on pyridine (*Proc.*, 1898, 14, 110).

In consequence of the results obtained, the work was somewhat extended, and it is shown that (1) an additive compound of chlorine and pyridine is formed, the constitution of which is not yet established; (2) Keiser's dichloropyridine hydrochloride is a trichloropyridine; (3) others of the chloropyridines seem to be formed in small amount; (4) the compound, C_5H_5NCl , described by Keiser as an addition product of chlorine and pyridine, is pyridine hydrochloride.

77. "The oxidation of paranitrotoluenesulphonic acid to dinitrostilbenedisulphonic acid and to paranitrobenzaldehydorthosulphonic acid." By R. Herz and W. H. Bentley.

In this paper the authors describe their experiments on the oxidation of sodium paranitrotoluenesulphonate by sodium hypochlorite. By using much less caustic soda than Green and Wahl (*Ber.*, 1897, 30, 3097), they find that the product of oxidation is almost entirely sodium dinitrostilbenedisulphonate, and that sodium dinitrodibenzyl-disulphonate does not appear to be produced. The sodium, silver, barium, and lead salts, as well as the acid, have been prepared and examined.

The authors are unable to accept the views of Ris and Simon (*Ber.*, 1898, 31, 354) on the constitution of the stilbene derivative, and from a determination of the amount of potassium permanganate required for its oxidation, maintain that it is a dinitro- and not a nitrosonitro-compound. They found, independently of Green and Wahl, that, on oxidising sodium dinitrostilbenedisulphonate in the cold with potassium permanganate, sodium paranitrobenzaldehydorthosulphonate is formed. This substance possesses the properties of an aldehyde, and forms yellow, crystalline compounds with phenylhydrazine and semicarbazide.

78. "Determination of molecular weights:—modification of Landsberger's boiling point method." By James Walker and John S. Lumsden.

The authors propose a modification of Landsberger's method (*Ber.*, 1898, 31, 458) which consists essentially in measuring the volume of the solution after the boiling point has been determined, instead of ascertaining its weight. This is effected by graduating the boiling tube, and permits of a number of successive experiments being made with the same quantity of substance. Only one weighing is necessary for the whole series, which occasions a considerable saving of time, making it possible to obtain four or five determinations in the course of half an hour. The accuracy is comparable with that of the Victor Meyer vapour density method in ordinary circumstances.

ADDITIONS TO THE LIBRARY.

I. *Donations.*

Goode, George Brown (Editor). The Smithsonian Institution, 1846—1896. The History of its First Half Century. City of Washington, 1897. Royal 8vo. Pp. x+856, with 26 full-page illustrations. Smithsonian Publication No. 1086.

Howe, Jas. Lewis. Bibliography of the Metals of the Platinum Group: Platinum, Palladium, Iridium, Rhodium, Osmium, Ruthenium. City of Washington, published by the Smithsonian Institution, 1897. 8vo. Pp. 318. From Smithsonian Miscellaneous Collections, 38, (No. 1084).

Copy of Jubilee Medal in bronze.

From M. Carteighe, Esq.

Neumann, Bernhard. The theory and practice of Electrolytic Methods of Analysis, translated by J. B. C. Kershaw. Pp. x+254. London 1898.

From the Publishers.

Bottone, S. R. Radiography and the X-rays in practice and theory with constructional and manipulatory details. Pp. x+176. London 1898.

From the Publishers.

Obach, E. F. A. Cantor Lecture on Gutta Serena. Pp. 102. (Reprinted from the *Journal of the Society of Arts*.) London 1898.

From the Author.

II. *By Purchase.*

Paracelsus. The hermetic and alchemical writings of Aureolus Philippus Theophrastus Bombast of Hohenheim, called Paracelsus, edited by A. E. Waite. 2 vols. 4to. Pp. xvi + 394 and viii + 396. London 1894.

The Hermetic Museum. The illustrations produced in facsimile. Containing translations of the following works.

The Golden Treatise concerning the Philosopher's Stone.

The Golden Age come back.

The Sophic Hydrolith, or Water Stone of the Wise.

The Demonstration of Nature.

A Philosophical Summary.

The Path of the only Truth.

The Glory of the World, or Table of Paradise.

The Generation of Metals.

The Book of Alze.

Figures and Emblems concerning the Philosopher's Stone.

The Practice and Keys of Basil Valentine.

The Ordinal of Alchemy.

The Testament of John Cremer, sometime Abbot of Westminster.

The New Light of Alchemy.

The Sulphur of the Philosophers.

An Open Entrance to the Closed Palace of the King.

A Subtle Allegory concerning the Secrets of Chemistry.

The Metamorphosis of Metals.

A Short Guide to the Celestial Ruby.

The Fount of Chemical Truth.

The Golden Calf.

The All-wise Doorkeeper.

2 vols. 4to. Pp. xi + 357 : and 352. London 1893.

Collectanea Chemica, being certain select treatises on Alchemy and Hermetic Medicine, by Eirenæus Philalethes, Francis Anthony, George Starkey, Sir George Ripley, etc.

The Secret of the Immortal Liquor called Alkahest.

Aurum Potabile.

The Admirable Efficacy of the True Oil of Sulphur Vive.

The Stone of the Philosophers.

The Bosom Book of Sir George Ripley.

The Preparation of the Sophic Mercury.

8vo. Pp. 160. London 1893.

Benedictus Figulus. A Golden and Blessed Casket of Nature's Marvels. Concerning the blessed mystery of the Philosopher's Stone.

8vo. Pp. xxxi + 361. London 1893.

Janus Lacinius. The New Pearl of Great Price. A treatise concerning the treasure and most precious stone of the philosophers. Illustrated with symbolical designs. 8vo. Pp. xi + 441. London 1893.

Edward Kelley. The Englishman's two excellent treatises concerning the Philosopher's Stone, together with the Terrestrial Theatre of Astronomy. 8vo. Pp. lxvii + 153. London 1893.

Basilius Valentinus. The Triumphal Chariot of Antimony, with the commentary of Theodore Kerckringius. Engraved title and plates. 8vo. Pp. xxxiii + 204. London 1893.

Jones, H. C. The Freezing-Point, Boiling-Point, and Conductivity Methods. Pp. vii + 64. Easton, Pa., 1897.

Threlfall, Richard. On Laboratory Arts. Pp. xii + 338. London 1898.

Journal of the Royal Agricultural Society. Vols. I—XXV, 1st Series, with General Index, 1840—1864. Vols. I—XXV, 2nd Series, with General Index, 1865—1889. Vols. I—VI, 3rd Series, 1890—1895.

Pamphlets.

Liversidge, A. Abbreviated names for certain Crystal forms.

—— Models to show the Axes of Crystals.

—— Variation in the amount of free and albuminoid Ammonia in

Waters, on keeping ; On the Corrosion of Aluminium.

— Crystallised Carbon Dioxide ; on the Internal Structure of Gold Nuggets ; Contributions to the Bibliography of Gold ; Experiments on the Waterproofing of Bricks and Sandstones with Oils ; Experiments upon the Porosity of Plasters and Cements. (Reprinted from the *Transactions* of the Australasian Association for the Advancement of Science.)

— On some New South Wales and other Minerals. Note No. 7.

— On the Amount of Silver and Gold in Sea Water.

— The Removal of Gold and Silver from Sea Water by Muntz Metal Sheathing. (Reprinted from the *Transactions* of the R.S.N.S.W.)

BANQUET TO PAST PRESIDENTS.

It has been arranged by the Council that the Society shall entertain at a Banquet at the Hôtel Métropole, on June 9th, the following Past Presidents who have completed a period of fifty years Fellowship of the Society :—Lord Playfair : Sir J. H. Gilbert : Sir E. Frankland : Prof. Odling : Sir F. A. Abel, Bart. : Dr. A. W. Williamson : Dr. J. H. Gladstone. The Secretaries will be glad to hear as soon as possible, and *in any case not later than May 14th*, from those Fellows who intend to be present, and also if they desire to bring guests (at present limited to two).

The price of tickets will be One Guinea each, including wine. They will be forwarded on receipt of a remittance for the number of tickets required, addressed to the Assistant Secretary, Chemical Society, Burlington House, W.

RESEARCH FUND.

A meeting of the Research Fund Committee will be held in June. Applications for grants, accompanied by full particulars, should be sent to the Secretaries on or before June 6th.

At the next meeting, on Thursday, May 19th, the following papers will be communicated by the authors.

“The action of formaldehyde on amines of the naphthalene series.”
By G. T. Morgan, B.Sc.

“On the constitution of oleic acid and its derivatives. Part I.” By F. G. Edmed, B.Sc.

PROCEEDINGS
OF THE
CHEMICAL SOCIETY.
EDITED BY THE SECRETARIES.

No. 195.

Session 1897-8.

May 19th, 1898, Professor Dewar, F.R.S., President, in the Chair.

Messrs. T. M. Lowry, H. St. John, and J. Heaton were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. John Brighthouse Buchan, 17, Steven Street, Stretford, Manchester; Charles William Tisdale Davies, Wye, Kent; Robert Findlay Hislop, Craigielea, Paisley; George Herbert Martin, New College, Eastbourne; Charles James Meads, Brooklynn, Erlanger Road, St. Catherine's Park, S.E.; Matthew Joseph Sheridan, 20, Heathland Road, Stoke Newington, N.

The following papers were read :—

79. "The liquefaction of hydrogen and helium." By James Dewar, LL.D., F.R.S.

In a paper entitled "The liquefaction of air and research at low temperatures (*Proc.*, 1895, 11, 221), an account was given of the history of the hydrogen problem and the result of the author's experiments to the end of the year 1895. The subject was again discussed in a lecture on "New researches on liquid air" (*Proc. Roy. Inst.*, 1896, 15, i, 144), and a sketch given of the apparatus employed for the production of a jet of hydrogen containing liquid. It was shown that such a jet could be used to cool substances below the temperature which could be reached by the use of liquid air, but all attempts to collect the liquid in vacuum vessels failed. The type of apparatus used in these experiments worked well, so it was resolved to construct a much larger liquid air plant, and to combine with it circuits and arrangements for the liquefaction of hydrogen. This apparatus, admirably constructed by the engineers,

Messrs. Lennox, Reynolds and Fyfe, took a year to build up, and many months were occupied in testing and making preliminary trials. The many failures and defeats need not be detailed.

On May 10th, hydrogen was liquefied by allowing the gas, cooled to -205° , and under a pressure of 180 atmospheres, to escape continuously at the rate of from 10 to 15 cubic feet per minute from the nozzle of a coil of pipe in a double silvered vacuum vessel of special construction surrounded with a space kept below -200° . Liquid hydrogen commenced to drop from this vacuum vessel into another doubly isolated by being surrounded with a third. On this occasion, 20 c.c. of liquid hydrogen were collected in about five minutes, and on May 12th 50 c.c. were obtained before the hydrogen jet froze up from the solidification of air in the pipes. The yield of liquid was about 1 per cent. of the gas. The hydrogen in the liquid condition is clear and colourless, showing no absorption spectrum and the meniscus is as well defined as in the case of liquid air. The liquid must have a relatively high refractive index and dispersion, and the density appears to be in excess of the theoretical value, 0.18 to 0.12, deduced respectively from the atomic volume of organic compounds and from the limiting density found by Amagat for hydrogen gas under infinite compression. The author's experiments on the density of hydrogen in palladium gave a value 0.62 for the substance in combination, and it will be interesting to find the density of the actual liquid at its boiling point. Not having arrangements at hand to determine the boiling point, two experiments were made to prove the excessively low temperature of the boiling fluid. In the first place, a long piece of glass tubing, sealed at one end, but open to the air at the other, and cooled by immersing the closed end in liquid hydrogen, immediately filled, where it was cooled, with solid air. The second experiment was made with a tube containing helium.

The Bulletin of the Cracow Academy for 1896 contains a paper by Professor Olszewski, entitled "A research on the liquefaction of helium," in which he states that "as far as my experiments go, helium remains a permanent gas and apparently is much more difficult to liquefy than hydrogen." Helium which had been extracted from Bath gas by the liquefaction method described last year (*Proc.*, 1897, 13, 190) and sealed up in a bulb with a narrow tube attached, was placed in liquid hydrogen, and a distinct liquid was seen to condense. A similar experiment made with the same helium tube in liquid air under exhaustion instead of in liquid hydrogen gave no visible condensation. It would thus appear, as already suggested by the author (*loc. cit.*), that there cannot be any great difference in the boiling points of helium and hydrogen. A fuller account of the work will appear in the *Transactions*.¹

All known gases have now been condensed into liquids which can be manipulated at their boiling points under atmospheric pressure in suitably arranged vacuum vessels. With hydrogen as a cooling agent, it will be possible to get within 20° or 30° of the zero of absolute temperature, and its use will open up an entirely new field of scientific inquiry.

During the whole course of the low temperature work carried out at the Royal Institution, the invaluable aid of Mr. Robert Lennox has been at the author's disposal, and it is not too much to say that, but for his engineering skill, manipulative ability, and loyal perseverance, the present successful issue might have been indefinitely delayed. The author's thanks are also due to Mr. J. W. Heath for valuable assistance in the conduct of these experiments.

DISCUSSION.

Sir WILLIAM CROOKES proposed that the Fellows of the Society should offer their best congratulations to the President on the striking success which had attended his remarkable attempts to liquefy the last of the 'permanent' gases—hydrogen and helium.

Dr. ARMSTRONG, in seconding the proposal, said that in the future the fact that the liquefaction of hydrogen had been achieved by a President of the Society would no doubt be recalled with interest. In early days, the discussion of the properties of hydrogen had attracted much attention in the Society when Sir Benjamin Brodie advocated the view that it must be supposed to have metallic properties, a view subsequently strongly supported by Graham's discovery of hydrogenised palladium. He ventured to think, however, that the subject had been regarded too much from the inorganic side, and that when the evidence to be derived from organic chemistry was taken into account, it was more probable that hydrogen would be found to resemble the petroleum hydrocarbons rather than the metals.

He then asked whether the President's statement that argon solidified when cooled in liquid air did not preclude the presence of argon in the helium from Bath gas, which gave only a liquid when cooled in hydrogen.

The motion was carried by acclamation.

The PRESIDENT, in acknowledging the compliment, said that the facts referred to by Dr. Armstrong proved that the helium employed in the liquefaction experiments did not contain argon. It was possible that hydrogen might be present in small quantity, but otherwise the helium was pure.

80. "The action of formaldehyde on amines of the naphthalene series. Part I." By Gilbert T. Morgan, B.Sc.

By the interaction of methylal, acetone, and β -naphthylamine, Reed (*J. prakt. Chem.*, 1887, **35**, 314) obtained naphthacridine, $C_{21}H_{13}N$ (m. p. 216°), and a substance melting at $202-203^\circ$, to which he gave the formula $C_{24}H_{20}N_2$.

The author finds that when formaldehyde (40 per cent. solution) acts on β -naphthylamine in alcoholic solution in the presence of hydrochloric acid, four basic substances are produced. Two of these have the composition corresponding with the formula $C_{21}H_{13}N$; one crystallises in orange needles melting at $225-226^\circ$, and the other in straw coloured needles melting at 216° . The latter was found to be identical with naphthacridine.

The third substance crystallises in colourless prisms often showing cruciform twinning, melts at 203° , and is identical with the compound of this melting point described by Reed. Its composition is expressed by the formula $C_{23}H_{18}N_2$, and as the author has obtained it by the action of formaldehyde alone on β -naphthylamine, it follows that acetone plays no part in the condensation.

The fourth compound is obtained only in small quantity, crystallises in silky needles having a faintly yellow tinge, melts at $186-187^\circ$, and has the formula $C_{22}H_{16}N_2$. Its *hydrochloride*, $C_{22}H_{16}N_2 \cdot HCl$, and *nitrite*, $C_{22}H_{16}N_2 \cdot HNO_2$, have been prepared, and the base can be regenerated from either salt by means of aqueous alkalis.

The orange coloured base melting at $225-226^\circ$ stands in very close relationship to the isomeric naphthacridine (m. p. 216°), and is converted into it both easily and quantitatively. Its behaviour with hydrogen chloride is remarkable. When it is triturated with concentrated hydrochloric acid or submitted to the action of the dry gas, it forms a green hydrochloride, from which the orange base is obtained; but when dry hydrogen chloride is passed into its solution in benzene or in glacial acetic acid a yellow hydrochloride is produced, which yields naphthacridine (m. p. 216°). The orange base is probably a labile form of naphthacridine. Methods for preparing each form in quantity are given in the paper, and the *hydriodide*, *methiodide*, and *ethiodide* of naphthacridine (m. p. 216°) are described.

The products of the interaction between formaldehyde and α -naphthylamine have been examined with results which will be communicated in a subsequent paper, and the investigation is being extended to derivatives of both α - and β -naphthylamine.

DISCUSSION.

Professor DUNSTAN pointed out that commercial formalin usually contains acetone, so that, unless the author had satisfied himself of the purity of the formaldehyde, the fact that the interaction of the commercial solution and β -naphthylamine gave rise to the condensation product did not necessarily tell in favour of the view that acetone was not concerned in the action.

Mr. MORGAN, in reply, said that the formaldehyde solution employed could have contained [only a small amount of acetone. The base melting at 203° is readily reduced to naphthacridine by means of hydriodic acid and phosphorus, and this fact not only supports the formula adopted by the author, but also—taken in conjunction with the large yield of the base when prepared from β -naphthylamine and formaldehyde—makes it improbable that acetone takes any part in the condensation.

81. "On the constitution of oleic acid and its derivatives. Part I."
By Frank George Edmed, B.Sc.

Oleic and elaidic acids, when oxidised by weak alkaline permanganate, yield two dihydroxystearic acids, melting respectively at 134° and 99° (Saytzeff, *J. Russ. Chem. Soc.*, 1885, 17, 417). The author finds that, while these acids are the chief products of the reaction, pelargonic, azelaic, and oxalic acids are also formed at the same time. These acids result from the continued action of the oxidising agent on the dihydroxystearic acids, and no evidence could be obtained of the formation of sebacic, suberic, and caprylic acids, which, with azelaic acid, have been stated to be the products of the further action of permanganate (Spiridonoff, *J. Russ. Chem. Soc.*, 1887, 19, 646). The dihydroxystearic acid obtained from elaidic acid is much more easily oxidised than its isomeride, a fact which is consistent with the stereoisomeric formula ascribed to elaidic acid. The formation of pelargonic and azelaic acids affords additional evidence in support of the formula, $\text{CH}_3(\text{CH}_2)_7\text{CH}:\text{CH}(\text{CH}_2)_7\text{CO}_2\text{H}$, for both oleic and elaidic acids.

Oleic acid was also oxidised with a weak solution of chromic acid; the action was very slow, and a considerable quantity of azelaic acid, but only a trace of pelargonic acid, was obtained. No other products could be isolated, and the action appears to be similar to that of the permanganate.

The products resulting from the fusion of oleic and of elaidic acids with potash were quantitatively examined, and it was found in both cases that the yield of palmitic acid was approximately theoretical, but that the quantity of acetic acid was extremely small. Oxalic acid was

also produced in the reaction, and the amount exceeded that of the acetic acid, but neither pelargonic nor azelaic acids could be detected, nor could any dihydroxystearic acid be recognised, although from Wagner's explanation of the reaction (*Ber.*, 1888, 21, 3353), this might be expected to be an intermediate product.

DISCUSSION.

Mr. HEHNER was by no means convinced that the double linkage occurred between the central carbon atoms in the oleic acid formula. No doubt oleic acid on oxidation formed azelaic acid by preference, but as by other means, for instance, by treatment with sulphuric acid or zinc chloride, lactones were very readily obtained, it seemed possible that oleic acid was a labile compound, and that the double linkage had not a definite position in the molecule. He was astonished at the excellent yield of dihydroxystearic acid obtained by the author by means of alkaline permanganate; in the most favourable circumstances, he had been able to obtain only about 40 per cent. of the theoretical yield, and this, he thought, was also the experience of other workers. The oxidation by means of chromic acid might have succeeded better if a solution of chromic anhydride in acetic acid had been employed, instead of a mixture of bichromate and sulphuric acid. As to the deficiency in the yield of acetic acid in the potash fusion, might not some of the acetate have decomposed into methane?

The question arose whether oleic acid could be regarded as a single substance. The number of isomerides possible in the case of compounds containing eighteen carbon atoms was enormous, and, while many were well known among the lower members of the series, it was remarkable that when a chain of about ten carbon atoms was reached, all reference to isomerides disappeared from the text-books, solely, in his opinion, because means for their separation had not been devised. At the same time, indications existed, such as slight differences in the optical behaviour of oils of a similar degree of unsaturation, and in the solidifying points of the fatty acids separated from them, which pointed towards isomerism. It was essential to elucidate this point before studying the constitution of the substance called oleic acid, especially as most of the work which had been done was antecedent to the recognition of the existence of less saturated acids, such as linolic and linolenic acids and their homologues, which were almost invariably present with acids of the oleic class.

Dr. CROSSLEY was surprised to learn that a nearly theoretical yield of dihydroxystearic acid was obtained by oxidising oleic acid with permanganate, as in similar experiments he had never succeeded in obtaining more than 40 per cent. of the amount theoretically possible.

Referring to Wagner's explanation of the production of palmitic from oleic acid by fusion with potash, he pointed out that it received support from many cases in which this alkali seems to act simultaneously as an oxidising and reducing agent, and suggested that the fusion of oleic acid with soda might lead to interesting results, as caustic soda apparently does not exercise a reducing action.

Professor TILDEN said that, in his opinion, a body of evidence had been brought forward which amounted almost to positive proof of the correctness of the symmetrical formula for oleic acid. And, referring to the remarks of Mr. Hehner, he would venture to say that if it came to a question of the credibility of evidence, he should distinctly prefer the testimony derived from the action of a 1 or 2 per cent. solution of permanganate in the cold to that of such agents as zinc chloride or caustic potash, which required a high temperature.

Professor DUNSTAN doubted whether there was any real evidence that crystallisable oleic acid obtained from different oils is not a single substance. He thought it more probable that the differences Mr. Hehner had alluded to were due to impurities occurring in the natural oils.

Mr. EDMED, in reply, said that the quantitative yield of palmitic acid in the potash fusion precluded the supposition that the oleic acid employed contained a branched-chain isomeride. It was not possible to accept Mr. Hehner's suggestion that the small amount of acetic acid obtained was due to a decomposition of potassium acetate into methane during the reaction, as the temperature was not allowed to exceed 230° during the fusion.

82. "Stereoisomeric derivatives of camphor." By T. M. Lowry, B.Sc.

In addition to the case of stereoisomerism referred to in a previous note (*Proc.*, 1897, 13, 159), the author has investigated that of the dibromochlorocamphors, $C_8H_{13}Br\left<\begin{smallmatrix} CClBr \\ CO \end{smallmatrix}\right>$, obtained by heating chlorocamphor with an excess of bromine in sealed tubes. When recrystallised five times, the product melted at 81° and had a specific rotatory power $[\alpha]_D = 44.5^{\circ}$ in a 5 per cent. solution in chloroform; after five more crystallisations, the rotatory power was raised to 51.3° , but no increase was observed after sixteen further crystallisations. The melting point also was constant at 84° . There can be no doubt that the change in rotatory power indicates the presence of two stereoisomerides, and the product must, therefore, be an isomorphous mixture similar to that afforded by the bromochlorocamphors previously described, from which it differs only by the presence of an additional bromine atom in the β -position.

BANQUET TO PAST PRESIDENTS.

Fellows who have announced their intention of being present at the Banquet on June 9th are requested to send to the Assistant Secretary, Chemical Society, Burlington House, W., remittances for the number of tickets required *without delay*, in order that the tickets may be forwarded to them. The names of guests should also be notified.

RESEARCH FUND.

A meeting of the Research Fund Committee will be held in June. Applications for grants, accompanied by full particulars, should be sent to the Secretaries on or before June 6th.

At the next meeting, on Thursday, June 2nd, the following paper will be communicated by the authors.

“On the behaviour of certain organic substances towards hydrogen bromide in presence of ether.” By Henry J. Horstman Fenton, M.A., and Mildred Gostling, B.Sc.

CERTIFICATES OF CANDIDATES FOR ELECTION.

N.B.—The names of those who sign from “General Knowledge” are printed in *italics*.

The following Candidates have been proposed for election. A ballot will be held on Thursday, June 16th.

Brearley, Harry,

Totley, Derbyshire, via Sheffield.

Metallurgical Chemist at Messrs. Thos. Firth & Sons, Ltd. S. K. certificates in Mathematics (IV.), General Physics and Mechanics (adv.); subsequently two years Math. and Phys. at Firth College, also Chem. and Phys. Laboratory course. Metallurgical training in lab. Thos. Firth & Sons, Sheffield, under J. Taylor, B.Sc., A.R.S.M., &c.; last five years chief assistant. Author of “Estimation Mn in Spiegels,” *C.N.*, 75, 13; “Carbon in Ferrochromium,” *C.N.*, 75, 241; “Separations with Alkaline Acetates” *C.N.*, 75 and 76; “Cyanide Estimations of Copper,” *C.N.*, 76, 189, 291, 303, “Separations from Chromic Acid,” *C.N.*, 77.

R. Leffler.

William Crookes.

George Young.

Fred. Ibbotson.

Fredk. J. Merrils.

Buchan, John Brighthouse,

17, Steven Street, Stretford, Manchester.

Managing Partner of The Anchor Chemical Engineering Co., Stretford, Manchester. Laboratory Assistant at the Clayton Aniline Co.’s works, Manchester (3 years). Laboratory assistant and under-manager at Messrs. Brunner, Mond & Co.’s works, Northwich (6 years). Manager of Experimental Plant at Messrs. Peter Spence & Son’s works, Manchester (1 year). Manager of Messrs. Adley, Tolkien & Co.’s works, Blackburn (9 months). Left Blackburn to take up present position.

Daniel Bray.

R. L. Taylor.

Charles Crocker.

S. W. Harris.

Clarence A. Seyler.

Cowburn, Arthur William,
 "Fernroyd," Bowdon, Cheshire.

Chemist. Student of Chemistry between 1892 and 1895 at the Technical School, Manchester. Between 1894 and 1896 at Owens College, and pupil to Messrs. Crace, Calvert and Thomson, Royal Institution Laboratory of Manchester, since 1896.

William Thomson.	H. B. Dixon.
J. Carter Bell.	Harry Grimshaw.
Jas. Grant.	James Porter Shenton.

W. H. Perkin, junr.

Davies, Charles William Tisdale,
 Wye, Kent.

Student at the South-Eastern Agricultural College. Holder of Diploma and Silver Medal of British Dairy Farmers' Association for Science and Practice of Dairy Farming and Dairying, also Diploma of South Eastern Agricultural College for Scientific and Practical Agriculture. For 4 years Student of Chemistry, the latter 3 years being spent at the South-Eastern Agricultural College, Wye, Kent. Desirous of Fellowship of the Society whereby to obtain further knowledge (by means of its publications, &c.) of Chemistry, both Analytical and especially as applied to Agriculture and Dairying.

John Percival.	H. J. Monson.
Edward G. Guest.	<i>John M. Thomson.</i>
A. D. Hall.	<i>H. Brereton Baker.</i>

Dowzard, Edwin,
 30, The Willows, Liverpool.

Analytical Chemist. Three years as apprentice and assistant with the firm of Messrs. A. N. Tate & Co., Analytical Chemists, Liverpool. During the past 3 years analyst to Messrs. Evans, Sons & Co., Liverpool. Author of the following, "A Quick Polarimetric Method for the Estimation of Starch in Flour," *Chem. News*, 77, 107.

Francis Henry Tate.	F. Harwood Lescher.
Edward Davies.	<i>Francis Vacher.</i>

J. Campbell Brown.

Foulerton, Alexander Grant Russell,
 Dunsdale, Mulgrave Road, Sutton, Surrey.

Fellow of the Royal College of Surgeons, England. Assistant Bacteriologist, British Institute of Preventive Medicine. Engaged in investigations of Physiological Chemistry; formerly Demonstrator of Biological Chemistry, British Institute of Preventive Medicine.

Henry E. Roscoe.	Chas. Slater.
Arthur Harden.	Samuel Rideal.

Christopher Childs.

Hamilton, Oswald,

Old Stratford, Stony Stratford.

Chemical Engineer. Five years private assistant Owens College, Manchester. Two years private assistant University College, London, during which time assisted in the editing of *Journal of Society of Chemical Industry* and other scientific literature. Manager of the British White Lead Co., Ltd., 5 years, having designed and constructed plant and process. Researches on Blast Furnace products, lead compounds, and many others.

Watson Smith.

William Ramsay.

B. E. R. Newlands.

Henry E. Roscoe.

John A. R. Newlands.

Hemmy, Arthur Stanley, B.A., M.Sc.,

Government College, Lahore, India.

Professor of Physical Science. Formerly Assistant Professor of Chemistry, Heriot-Watt College, Edin. Joint author with Dr. S. Ruhemann of papers on Organic Chemistry.

S. Ruhemann.

M. M. Pattison Muir.

A. Sheridan Lea.

R. S. Morrell.

R. H. Adie.

Sidney Skinner.

Hislop, Robert Findlay,

Craigielea, Paisley.

Assistant Gas Engineer and Chemist, Gas Works, Paisley. Studied Chemistry for the past 10 years under Professor Ferguson, of Glasgow University, the late Professor Dittmar, of the Andersonian College, Glasgow, and under Messrs. R. R. Tatlock and Reedman, City Analysts, Glasgow, and for the past 5 years have acted as chemist, &c., at the Paisley Gasworks. Have considerable experience in analysis of Coals and Coke for gas, steam, domestic, and metallurgical purposes.

Geo. R. Hislop.

R. R. Tatlock.

James Robson.

Thomas Gray.

G. G. Henderson.

Matthew A. Parker.

Jarvis, George Arthur,

The Shrubbery, Snedshill, Wellington, Salop.

Analytical and metallurgical chemist. Over 22 years' experience as analytical chemist. Technical Education lecturer. Three and a half years with Edward Riley, F.I.C., F.C.S. Assistant chemist Wigan Coal and Iron Co., Ltd. Chemist to West Yorkshire Iron and Coal Co., Ltd. Three and a half years chemist New Russia Co., Ltd.

Assistant to late Sidney Gilchrist Thomas. 13 years chemist to The Lilleshall Co., Ltd.

Edwd. Riley.

Percy Elford.

F. W. Hart.

Geo. P. Rees.

Wm. P. Thompson.

Lee, Harry Lancelot,

8, Chichester Street, St. George's Square, London, S.W.

Lecture Assistant in the School of the Pharmaceutical Society. Studied Chemistry for three years in the Pharmaceutical Society's School. Student Session 1894—5. Lecture Assistant to Prof. Dunstan, Session 1896. Lecture Assistant to Prof. Collie, Sessions 1896—7, 1897—8.

John Norman Collie.

Wyndham R. Dunstan.

Ernest Goulding.

Arthur Lapworth.

Thomas Tickle.

Lewins, William,

43, Exeter Street, Gateshead.

Science Teacher, Organised Science School, Gateshead. Bachelor of Science, London University. Lecturer in Chemistry in the above School for five years.

P. Phillips Bedson.

Saville Shaw.

F. C. Garrett.

R. Greig Smith.

J. G. Taylor.

Martin, George Herbert,

New College, Eastbourne.

Science Master. Late Science Postmaster of Merton College, Oxford. B.A. 1st Class in Final Honour School of Natural Science. Formerly Science Master at (i) Clergy Orphan School, Canterbury, (ii) Wellington College, Berks. At present Science Master at New College, Eastbourne. Assisted Dr. Rideal in the investigation of the chemical actions which take place in the Septic Tank System of Sewage treatment.

W. W. Fisher.

Samuel Rideal.

John Watts.

J. E. Marsh.

V. H. Veley.

William Esson.

Meads, Charles James,

Brooklynn, Erlanger Road, St. Catherine's Park, S.E.

Chemist. Two years Student at Royal College of Science (1894—6). Two years Assistant in Government Laboratory (1896—8). Two years Demonstrator, Birkbeck Institution (1896—8).

T. E. Thorpe.

H. J. Helm.

E. Grant Hooper.

J. Woodward.

William A. Tilden.

John E. Mackenzie.

Nash, Leonard Myddleton,

281, Seven Sisters' Road, Finsbury Park, N.

Chemist to Colour Works. Studied Chemistry and Metallurgy in King's College, London, from 1895—1898. Passed the Intermediate Examination of the Institute of Chemistry, 1898. Also worked with Mr. Bertram Blount. Became M.S.C.I. in 1897.

John M. Thomson.

Bertram Blount.

Herbert McLeod.

Herbert Jackson.

Patrick H. Kirkaldy.

A. K. Huntington.

William H. Sodeau.

Neilson, Alexander MacGillivray

c/o Messrs. T. Stanes & Co., Coimbatore, Madras, India.

Analytical Chemist. Four years with Messrs. McCowan and Biggart, Public Analysts, Greenock. Six years with Messrs. Alex. Cross and Sons, Limited, at Port Dundas Chemical Works, Glasgow. Now Chemist to Messrs. T. Stanes and Co., Coimbatore, India. Have studied Chemistry and other sciences at Holmscroft Science School, Greenock, the Technical College, and the University of Glasgow.

John Wm. Biggart.

John Peden, jun.

Alexander M. Forrester.

James Robson.

Angus Smith.

Matthew A. Parker.

Thomas Gray.

Russell, Edward John,

The Owens College, Manchester.

Demonstrator in Chemistry in the Owens College. Two years in the Laboratories Univ. Coll., Aberystwyth. One year in the Laboratories, Owens College. B.Sc. 1st Class Honours Chemistry, London Univ., 1896. For two years private assistant to Prof. H. B. Dixon. Joint author of paper "On the Explosion of Chlorine Peroxide with Carbonic Oxide," *Journ. Chem. Soc.*, 1896.

Harold B. Dixon.

J. F. Thorpe.

W. H. Perkin, jun.

A. William Gilbody.

P. J. Hartog.

Sheridan, Matthew Joseph,

20, Heathland Road, Stoke Newington, N.

Member of Her Majesty's Civil Service. For 10 years Senior Assistant Analyst in the Laboratory of H.M. Customs; two years in Finsbury Technical College under Prof. Meldola; and at present at the Royal College of Science, London.

T. E. Thorpe.

William A. Tilden.

W. Palmer Wynne

M. O. Forster.

G. T. Morgan.

Stein, Sigmund,

323, Vauxhall Road, Liverpool.

Chemist and Manager of the Sugar Refinery of Messrs. Crosfield, Barrow and Co., Liverpool. Student of the Vienna Polytechnicum and University for five years; Chemist in various Continental Sugar Works and Distilleries; seven years with Messrs. Crosfield, Barrow and Co.

George Tate.

Francis Henry Tate.

Thomas J. Roberts.

Joseph T. Freestone.

Edward Davies.

Steinhart, Oscar Julian,

4, Palace Street Mansions, London, S.W.

Technical Chemist. Ph.D., University of Erlangen (Bavaria). Dissert., "Über einige Anisylamine." Five years' study Polytechnicum and Universities of Munich and Erlangen. Two and a half years Managing Chemist to May and Baker, Limited, London, S.W. Three years Chemist to Chemical and Electrolytical Syndicate, Offices, 6 Clement's Lane, E.C.

William Crookes.

Herbert Jackson.

John M. Thomson.

B. E. R. Newlands.

F. Maxwell Lyte.

R. H. Harland.

John A. R. Newlands.

Tucker, Samuel Auchmuty,

Columbia University, New York.

Tutor in Industrial Chemistry. Graduate of Columbia College School of Mines, 1895, receiving degree Ph.B., Course of Analytical and Applied Chemistry. For 2 years as Assistant in Toxicology and Assistant Demonstrator of Chemistry and Physics, College of Physicians and Surgeons, New York. Present position, Tutor, Industrial Chemistry, Columbia University, New York.

C. F. Chandler.

Elwyn Waller.

H. T. Vulté.

Fredc. H. Bowman.

Jas. S. C. Wells.

Arthur H. Elliott.

Waller, Henry Trench,

Zeehan, Tasmania.

Instructor in Analytical Chemistry and Assaying to the Zeehan School of Mines. Royal College of Science, London, 18 months as Student, passing in Inorganic and Analytical Chemistry; Physics, Part I.; Mechanics, Part I.; Astronomical Physics. Government Analysts' Office, Hobart, 9 months as Student. School of Mines, Ballarat, Victoria, 12 months as Student, passing in Analytical

Chemistry, Grades I., II., and III. ; Theoretical Chemistry, Grade III. ; Metallurgy, Grade I. ; Assaying, Grade I. Zeehan School of Mines, Tasmania, Instructor in Analytical Chemistry and Assaying 12 months.

H. Droop Richmond.

W. Palmer Wynne.

T. E. Thorpe.

Basil Turner.

A. J. Bensusan.

Weston, Frank Edwin,

43, Larkhall Rise, Clapham, S.W.

Teacher of Chemistry at the Polytechnic Institute, Regent Street, W. Teacher of Chemistry since November, 1893, in the Day Classes and Evening Classes of the above Institution. Passed Inter. Sci., London University (Honours in Chemistry), 1891.

Charles E. Browne.

Geo. Stubbs.

Frank Gossling.

J. Woodward.

C. H. Burge.

J. H. Robbins.

E. Grant Hooper.

Whitaker, Edmund Thomas,

Swan Hill Court, Shrewsbury.

Medical Officer of Health. M.B., C.M., B.Sc. (Edin.). D.P.H., Cambridge. Fellow of Society of Medical Officers of Health, Member of Hon. Soc. of Inner Temple, Member of Sanitary Institute, &c.

Douglas MacLagan.

W. Ivison Macadam.

Thos. P. Blunt.

Walter D. Severn.

S. Arch. Vasey.

Wild, William Ernest,

230, Turton Road, Bromley Cross, nr. Bolton.

Analytical and Consulting Chemist. Graduate (B.Sc.), in Chemistry, of Victoria University. Assistant for three years to Messrs. Crace, Calvert and Thomson, Analytical and Consulting Chemists, of Manchester, and at present Chemist to Messrs. James Hardcastle & Co., Bleachers, Dyers, Calico Printers and Finishers, with which firm I have been connected $4\frac{1}{2}$ years.

William Thomson

Henry E. Roscoe.

H. B. Dixon.

D. T. Lawrence.

A. William Gilbody.

Williamson, William,

86, Tyndall Road, Leyton, E.

Analyst in the Laboratory of H.M. Customs. Studied Chemistry at Gordon's College, Aberdeen, and at the Heriot-Watt College,

Edinburgh. Studied for two years at the Royal College of Science under Professor Tilden.

T. E. Thorpe.

William A. Tilden.

W. Palmer Wynne.

M. O. Forster.

G. T. Morgan.

Witham, Ernest,

The Grammar School, Rotherham.

Schoolmaster. Science Master at the Rotherham Grammar School for six years. Engaged during spare time in research in Chemistry at University College, Sheffield.

W. Carleton Williams.

George Young.

L. T. O'Shea.

Fred Ibbotson.

William H. Oates.

Wrench, Charles Arthur,

3, Parklands, Surbiton Hill.

Assistant Chemist to Messrs Stevenson and Howell, 95A, Southwark Street, S.E. For sixteen months with Messrs. Helbing and Passmore Analytical Chemists, and for four years with Messrs Stevenson and Howell, Manufacturing Chemists, 95A, Southwark Street, London, S.E.

H. Helbing.

William Stevenson.

Reginald Howell.

E. Russell Budden.

John Heron.

Wyndham R. Dunstan.

Chas. Geo. Matthews.

Adrian J. Brown.

PROCEEDINGS
OF THE
CHEMICAL SOCIETY.
EDITED BY THE SECRETARIES.

No. 196.

Session 1897-8.

June 2nd, 1898, Professor Dewar, F.R.S., President, in the Chair.

Messrs. A. L. H. Garside and K. J. P. Orton were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. Walter Birkett, 23 Cheviot Street, Lincoln; Alfred Hartridge, 14 Broad Street, Oxford; Charles William Tuthill Woods, St. Kilda, Tudor Road, Upper Norwood.

THE DEATH OF LORD PLAYFAIR.

The PRESIDENT said that the melancholy duty devolved on him to announce the death of the Right Hon. Lord Playfair, P.C., G.C.B., LL.D., F.R.S., the senior Past President and last surviving Founder of the Society, which took place on Sunday, May 29th. It was needless for him to dwell on Lord Playfair's scientific standing, or well recognised position in public life; he would only refer to the fact that he was the creator of a new type of public servant, and his services to education and as a member of Royal and Departmental Commissions on subjects connected with the public welfare were so unquestioned that it would be well for the country if there were more such men. Lord Playfair was ever ready to acknowledge his indebtedness to Liebig, Graham, and his other teachers, and proud to attribute his successful career to his early training in scientific method as a chemist. The Society would be represented at the funeral at St. Andrews by a former President, Professor Crum Brown, F.R.S.

In consequence of the death of Lord Playfair, the Banquet to the Past Presidents, arranged for June 9th, had been postponed until Friday, October 28th.

The following papers were read :—

83. "The boiling point and density of liquid hydrogen." By James Dewar, LL.D., F.R.S.

The boiling point of liquid hydrogen at atmospheric pressure has been determined by a platinum resistance thermometer. This was constructed of pure metal and had a resistance of 5.3 ohms at 0° C., which fell to about 0.1 ohm when the thermometer was immersed in liquid hydrogen. On reduction of this resistance to normal air temperatures, the boiling point is found to be -238.2° and -238.9° respectively by two methods, and to be -237° by a Dickson formula calculated for this thermometer (*cf. Phil. Mag.*, 1898, 45, 525). The boiling point of the liquid is, therefore, about -238° C or 35° absolute, and is thus about 5° higher than that obtained by Olszewski by the adiabatic expansion of the compressed gas, and about 8° higher than that deduced by Wroblewski from van der Waals' equation. It may be inferred that the critical point of hydrogen is about 50° absolute, and that the critical pressure will probably not exceed 15 atmospheres. As molecular latent heats are proportional to absolute boiling points, the latent heat of liquid hydrogen will be about two-fifths that of liquid oxygen. From analogy, it is probable that the practicable lowering of temperature to be obtained by evaporating liquid hydrogen under pressures of a few mm. cannot amount to more than $10-12^{\circ}$ C., and it may be said with certainty that no means are at present known for approaching nearer than $20-25^{\circ}$ to the absolute zero of temperature. The platinum resistance thermometer used had a zero point of -263.2 platinum degrees, and when immersed in boiling liquid hydrogen, indicated a temperature of -256.8° on the same scale, or 6.4 platinum degrees from the point at which the metal would become a perfect conductor. The effect of cooling platinum from the boiling point of liquid oxygen to that of liquid hydrogen is to diminish its resistance to one-eleventh.

The approximate density of liquid hydrogen at its boiling point was determined by measuring the volume of the gas obtained by evaporating 10 c.c., and is slightly less than 0.07, or about one-sixth that of liquid marsh gas, which has a density of 0.41 and is the lightest liquid at its boiling point hitherto known. It is remarkable that, with so low a density, liquid hydrogen is so easily seen, has so well defined a meniscus, and can be so readily collected and manipulated in vacuum vessels. As hydrogen occluded in palladium has a density of 0.62, it follows that it must be associated with the metal in some other state than that of liquefaction. The atomic volume of liquid hydrogen at the boiling point is about 14.3, the atomic volumes of liquid oxygen and nitrogen being 13.7 and 16.6 respectively at their boiling points.

The density of the gas at the boiling point of liquid hydrogen is 0.55, or about one-half that of air, and is eight times that of the gas at ordinary temperatures. The ratio of the density of hydrogen gas at the boiling point to that of the liquid is approximately 1:100, as compared with a ratio of 1:255 in the case of oxygen.

The specific heat of hydrogen in the gaseous state and in hydrogenised palladium is 3.4, but may very probably be 6.4 in the liquid substance. Such a liquid would be unique in its properties, but as the volume of one gram of liquid hydrogen is about 14—15 c.c., the specific heat per unit volume must be nearly 0.5, which is about that of liquid air. It is highly probable, therefore that the remarkable properties of liquid hydrogen predicted by theory will prove to be susceptible of explanation when they are compared with those of liquid air, volume for volume, at corresponding temperatures as defined by van der Waals.

84. "The action of hydrogen bromide in presence of ether on carbohydrates and certain organic acids." By Henry J. Horstman Fenton, M.A., and Mildred Gostling, B.Sc.

It has been previously shown by one of the authors (*Trans.*, 1896, 67, 553) that ethylic dihydroxymaleate can be readily produced by the interaction of the acid with anhydrous ether in presence of hydrogen bromide. This behaviour of ether as a "base" being unusual, at any rate, towards organic acids, it was considered desirable to make experiments with other acids in a similar manner; the results indicate that the reaction is a general one, and that the yields are satisfactory.

The study of the behaviour of ether and hydrogen bromide is now being extended to substances other than acids, and an account is given of the results obtained with carbohydrates and allied polyhydric alcohols. Certain of these substances develop an intense purple coloration, and it is found that the presence of ether, although advantageous, is not essential for its production. The coloured substance seems to resemble the compound described by Stenhouse and others as 'metafurfurol.' So far as the investigation has proceeded, ketohexoses and carbohydrates such as inulin which yield them on hydrolysis give an intense purple coloration in the course of an hour or two, aldohexoses give a purple coloration of comparatively moderate intensity in the course of a day or two, and other carbohydrates such as arabinose, rhamnose, starch, and cellulose, and alcohols such as mannitol, dulcitol and glycerol, give a brown, red, or yellow coloration free from any shade of purple. The only exception to this classification yet met with is xylose, which, although in the purest state obtainable, behaves similarly to the ketohexoses.

DISCUSSION.

Mr. CHAPMAN asked whether the authors had made any experiments with hydrogen chloride. Bouillon-Lagrange and Vogel (*Annales de Chimie*, 1809, 71, 91) had stated that both cane-sugar and milk-sugar absorb hydrogen chloride forming coloured products, which evolve the gas with effervescence on treatment with sulphuric acid.

Mr. FENTON, in reply, said that hydrogen chloride gives only a slight red colour, even after long standing, and that hydrogen iodide acts as a reducing agent liberating iodine.

85. "Production of some chloropyridinecarboxylic acids." By J. N. Collie, Ph.D., F.R.S., and W. Lean.

The authors have prepared from ethylic chlorolutidinecarboxylate (*Trans.*, 1897, 71, 303) several chloropyridinecarboxylic acids and, by reducing one of them with tin and hydrochloric acid, carbocinchomeric acid, which is also one of the products of the action of oxidising agents on quinine and several other alkaloids.

Ethylic chlorolutidinemonocarboxylate was prepared by the action of phosphorus pentachloride on ethylic oxylutidinecarboxylate. It is a sweet smelling liquid boiling at 288—290°. *Chlorolutidinecarboxylic acid* can be obtained by hydrolysis of the ethylic salt; it crystallises in small needles melting at 148°. By the action of potassium permanganate on the ethylic salt, two acids were obtained, one having the formula $C_5HN(CO_2H)_2(CO_2Et)Cl$, ($\alpha\gamma:\beta:\alpha'$) and melting at 169°, the second being an α' -chloropyridine- $\alpha\beta\gamma$ -tricarboxylic acid, $C_5HN(CO_2H)_3Cl$, melting at 212°. The latter acid yielded carbocinchomeric or pyridine- $\alpha\beta\gamma$ -tricarboxylic acid, $C_5H_2N(CO_2H)_3$, when reduced with tin and hydrochloric acid.

At the next meeting, on June 16th, there will be a ballot for the election of Fellows, and the following papers will be communicated by the authors.

"Preparation of a standard acid solution by direct absorption of hydrogen chloride." By G. T. Moody, D.Sc.

"Researches on the terpenes. III. Halogen derivatives of fenchene and their reactions." By J. A. Gardner, M.A., and G. B. Cockburn, B.A.

"Researches on the terpenes. IV. On the oxidation of fenchone." By J. A. Gardner, M.A., and G. B. Cockburn, B.A.

PROCEEDINGS
OF THE
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No. 197.

Session 1897-8.

June 16th, 1898, Professor Dewar, F.R.S., President, in the Chair.

Certificates were read for the first time in favour of Messrs. Edward Gardner, 27 Thurlow Road, Hampstead, N.W.; Henry J. S. Sand, 2 Cantlowes Road, Camden Square, N.W.

A ballot for the election of Fellows was held, and the following were subsequently declared duly elected.

Harry Brearley; Arthur William Cowburn; Charles W. Tisdale Davies; Edwin Dowzard; A. Grant Russell Foulerton; Oswald Hamilton; A. Stanley Hemmy, B.A., M.Sc.; Robert Findlay Hislop; George Arthur Jarvis; Harry Lancelot Lee; William Lewins, B.Sc.; George Herbert Martin, B.A.; Charles James Meads; Leonard Myddleton Nash; Alex. MacGillivray Neilson; Edward John Russell, B.Sc.; Matthew Joseph Sheridan; Sigmund Stein, Ph.D.; Oscar Julian Steinhart, Ph.D.; Samuel Auchmuty Tucker, Ph.B.; Henry Trench Waller; Frank Edwin Weston; Edmund Thomas Whitaker, B.Sc.; William Ernest Wild, B.Sc.; William Williamson; Ernest Witham; Charles Arthur Wrench.

Of the following papers those marked thus * were read.

*86. "Preparation of a standard acid solution by direct absorption of hydrogen chloride." By G. T. Moody.

A very rapid and accurate method of preparing a standard acid solution consists in absorbing hydrogen chloride in water, determining the resulting increase in weight, and subsequently diluting to a suitable bulk. The absorption is conveniently carried out in a conical glass flask, having a capacity of about 80 c.c., and closed by a glass stopper.

Through the stopper pass two tubes, one of which reaches nearly to the bottom of the flask and serves for delivery of the gas. From 2 to 4 grams of the gas may be absorbed in 40 c.c. of water in three minutes, and if the necessary apparatus for generating hydrogen chloride is kept fitted, a standard acid solution can be prepared in less than fifteen minutes.

*87. "Researches on the terpenes. III. Halogen derivatives of fenchene and their reactions." By John Addyman Gardner, M.A., and George Bertram Cockburn, B.A.

The authors give a further account of the properties of chlorofenchene phosphonic acid, $C_{10}H_{14}Cl \cdot PO(OH)_2$ (*Trans.*, 1897, 71, 1156), and describe the halogen derivatives of fenchene produced during its formation. The first action of phosphorus pentachloride on fenchene results in the replacement of the oxygen atom by chlorine, and production of two isomeric liquid substances, termed α - and β -chlorofenchene hydrochloride. These two isomerides cannot be separated by fractional distillation, but distil together at 105° — 110° under 16 mm. pressure. The α -isomeride is, however, very much the less stable of the two, and loses hydrogen chloride very readily, even when distilled with steam, producing chlorofenchene. The β -isomeride is much more stable towards reagents, and does not lose hydrogen chloride by boiling with aniline; this elimination can be effected, however, by prolonged heating with zinc dust and glacial acetic acid, and chlorofenchene is obtained. Unlike the chlorocamphene hydrochlorides, β -chlorofenchene hydrochloride is completely decomposed by warming with strong sulphuric acid, and yields no substance analogous to camphenol.

Chlorofenchene, $C_{10}H_{15}Cl$, is a crystalline substance very like chlorocamphene in appearance. It boils at 80 — 83° under 16 mm., and at 190 — 192° under the ordinary pressure. It is very soluble in alcohol, ether, benzene, light petroleum, chloroform, and carbon disulphide, the vapour of the last being sufficient to liquefy it. It has a specific rotatory power of $[\alpha]_D = +35.92^\circ$. Chlorofenchene slowly reacts with phosphorus pentachloride, and chlorofenchene phosphonic acid is formed on treating the product with water.

When sodium chlorofenchene phosphonate is treated with bromine water, it is decomposed quantitatively into sodium phosphate and *chlorobromofenchene*, $C_{10}H_{14}ClBr$; this is a colourless oil which boils at 113° — 114° under 11 mm., but decomposes on boiling under atmospheric pressure. It has a specific gravity of 1.38039 at 16° , and a specific rotatory power of $[\alpha]_D = -8.42^\circ$. The halogen atoms cannot be eliminated by heating with aniline, with zinc dust and glacial acetic acid, or with sodium in methylic alcohol solution.

***88. "Researches on the terpenes. IV. On the oxidation of fenchone."**

By John Addyman Gardner and George Bertram Cockburn.

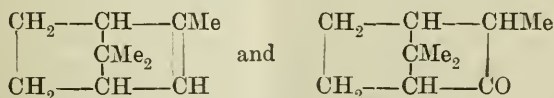
Fenchone is much more stable towards oxidising agents than camphor, but when oxidation does take place a much more complete breaking down of the molecule occurs. The authors have oxidised fenchone by prolonged heating on the water bath with concentrated nitric acid (sp. gr. 1.4). The action was very slow, and after heating for a week, they found that only about 50 per cent. of the ketone had been attacked. Isocamphoronic acid, dimethyltricarballic acid, dimethylmalonic acid, isobutyric acid, acetic acid, and nitrofenchone were isolated from the product of oxidation.

The isocamphoronic acid crystallised from ether and ethylic acetate in tabular plates melting at 163—164°, and is identical with the isocamphoronic acid obtained by Tiemann from campholenic acid. The yield was about 1.5 per cent. of the weight of the fenchone actually oxidised.

The dimethyltricarballic acid melted at 155°, and on treatment with acetic chloride gave an anhydride melting at 139—141°. The triethylic salt was a colourless liquid and boiled at 172—174° under 19 mm. pressure. The lead salt, $(C_8H_9O_6)_2Pb_3$, was an insoluble powder. The yield of this acid was 30 per cent., and of dimethylmalonic acid 4 per cent. of the fenchone oxidised.

Nitrofenchone is a colourless oil which distils at 146—151° under 14 mm. pressure, and on reduction with stannous chloride is converted into an amine.

The authors are of opinion that, if Bredt's formula be accepted for camphor, these results, taken together with the production of camphopyric acid from fenchene without the intermediate formation of camphoic acid, and from camphene, are sufficient to establish the formulæ



for fenchene and fenchone respectively.

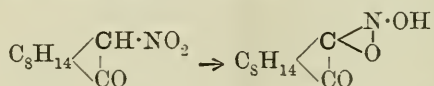
***89. "Nitrocamphor and its derivatives. Part I. Isodynamic forms of nitrocamphor."** By T. M. Lowry, B.Sc.

Although, theoretically, it should be possible to obtain two stereoisomerides of a compound represented by the formula $C_8H_{14} \begin{array}{l} \text{CH}\cdot\text{NO}_2 \\ \diagdown \\ \text{CO} \end{array}$, it appears that only one (the α') of the two possible forms of nitrocamphor

is produced under all ordinary conditions, since the various substances described as isomeric nitrocamphors have been found by the author to have the same properties when sufficiently purified.

The product obtained by heating nitrocamphor (*Proc.*, 1897, 13, 169) has the formula $C_{20}H_{28}N_2O_5$, and is identical with a substance already described by Cazeneuve as nitrosocamphor (*Bull. Soc. Chim.*, 1888, iii, 1, 558); it appears to be an *anhydride* formed by the removal of the elements of a molecule of water from two molecules of nitrocamphor, or rather of an isodynamic form of the latter which may be termed pseudonitrocamphor. This view finds support in the fact that the anhydride, like the salts formed from nitrocamphor, is strongly dextrorotatory, whereas nitrocamphor is levorotatory; and that when heated or acted on by alcoholic potash, it breaks up into camphorquinone and nitrous oxide, undergoing a change analogous to that which Nef has shown to take place on acidifying a solution of sodium ψ -nitroethane (*Annalen*, 1894, 280, 263).

If pseudonitrocamphor be represented by a formula corresponding to that which Hantzsch and Schultze have assigned to pseudophenylnitromethane, rather than by an isonitro-formula such as Nef has proposed, it is obvious that the conversion of nitrocamphor into the isodynamic form would not affect the asymmetry of the carbon atom to which the nitro-group is attached:



The author considers that important evidence of the independent existence of pseudonitrocamphor is afforded by the fact that solutions of nitrocamphor exhibit the phenomenon of multirotation hitherto observed only in the case of carbohydrates. This is true of $\pi\alpha'$ -bromonitrocamphor, in which the group $-CH(NO_2) \cdot CO-$ is also present, but not of $\alpha'\alpha'$ -nitrochlorocamphor, $\alpha'\alpha'$ -nitrobromocamphor nor of the anhydride or salts obtained from nitrocamphor, from all of which the hydrogen atom contiguous to the nitro-group has been eliminated. The extent to which the rotatory power of nitrocamphor changes corresponds to the formation of from 5 to 10 per cent. of the pseudo-form in solution.

It has not been found possible to isolate pseudonitrocamphor as yet. In the case of $\pi\alpha'$ -bromonitrocamphor, however, three different crystalline forms are known. The author is of opinion that the orthorhombic modification melting at 142° , which has a specific rotatory power changing from $+189^\circ$ to -40° in a 3.33 per cent. benzene solution, is the pseudo-form, and that the tetragonal form melting at 186° , which has a specific rotatory power changing from -50° to -40° , is the pure normal $\pi\alpha'$ -bromonitrocamphor. The third microcrystalline

modification, melting at 126° , appears to be composed of the two isodynamic forms in the ratio of one part of the normal to about five of the pseudo-compound. Equilibrium is attained in solution by all the three modifications at a point corresponding to the presence of only about 4 per cent of the pseudo-compound; the fact that this form is nevertheless the one most readily obtained on crystallisation is not difficult to account for as it is much less soluble than the normal compound.

The camphornitrophenol which Cazeneuve obtained by the action of concentrated muriatic acid on nitrocamphor obviously represents a third form of isomerism, as it behaves as a saturated compound and shows phenolic properties. Its behaviour is not explained by the formula, $C_8H_{14} \begin{smallmatrix} \text{C} \cdot \text{NO}_2 \\ | \\ \text{C} \cdot \text{OH} \end{smallmatrix}$, proposed by Cazeneuve, since this represents

it as being merely the enolic form of nitrocamphor. A change similar to that produced by hydrogen chloride occurs when benzoyl chloride acts on an alkaline solution of nitrocamphor, the product being camphornitrophenol benzoate. Cazeneuve has suggested that the formation of camphornitrophenol is due to the addition and subsequent loss of a molecular proportion of hydrogen chloride; it is possible that benzoyl chloride acts in a similar way by forming an additive compound from which hydrogen chloride is subsequently removed. The author is engaged in studying camphornitrophenol as well as its isomerides with a view of determining their inter-relationships.

*90. "Cannabinol." By T. B. Wood, M.A.; W. T. N. Spivey, M.A., and T. H. Easterfield, M.A., Ph.D.

Notwithstanding the experimental evidence already adduced by the authors in favour of the homogeneity of cannabinol (*Trans.*, 1896, 69, 539; *Proc.*, 1898, 14, 66), further investigation has shown that the substance is a mixture.

The crystalline acetyl derivative to which the formula $C_{15}H_{18}O_2$ was assigned (*Proc.*, *loc. cit.*) is found by molecular weight determinations to possess the formula $C_{23}H_{28}O_2$, which has the same percentage composition. This conclusion is supported by the determination of the acetyl and by the examination of the other product of hydrolysis, which has the composition and molecular weight required for the formula $C_{21}H_{26}O_2$. Most of the samples of cannabinol examined have yielded about 20 per cent. of the crystalline acetyl compound, together with an oily acetyl derivative containing a lower percentage of carbon.

The compound $C_{21}H_{26}O_2$ boils at $280\text{--}290^{\circ}$ under 80 mm. pressure. When dissolved in glacial acetic acid and treated in the cold with

fuming nitric acid, it yields a bright yellow, crystalline *nitro*-derivative, $C_{21}H_{23}N_3O_8$, which is more conveniently obtained by the action of nitric acid on cannabinol under similar conditions, the yield amounting to 20 per cent. of the cannabinol used. This nitro-derivative melts at 160° with decomposition, has acid properties, and gives characteristic *ammonium*, *potassium*, and *silver* salts which are sparingly soluble in water, but dissolve easily in alcohol, and have the general formula $C_{21}H_{23}N_3O_8M$. The *sodium* salt is comparatively soluble and crystallises with four molecular proportions of water. On reduction, the nitro-compound yields a corresponding base. Hot fuming nitric acid oxidises the nitro-compound to nitrocannabinolactone (oxycannabin), a mixture of acids being produced at the same time.

Amidocannabinolactone, $C_{11}H_{11}NH_2O_2$ (*Proc., loc. cit.*), has been diazotised and converted into a crystalline *iodolactone*, $C_{11}H_{11}IO_2$, which melts at 137.5° and can be sublimed. On removal of iodine from this compound by the action of sodium amalgam an oily lactone is obtained.

***91. "An improved form of gas-analysis apparatus."**

By William A. Bone.

The author has devised an improved form of gas-analysis apparatus, suitable for all purposes where considerable accuracy in estimating small quantities of gases is required.

The apparatus consists essentially of:—(1) A measuring vessel, A, made in one piece with a barometer tube, B. Both A and B are 700 mm. long, and have the same internal and external diameters, viz., 15 and 17 mm. respectively. B is very accurately graduated into millimetres. A and B are enclosed in a rectangular water jacket through which a stream of water at a constant temperature can be made to flow, and are connected by means of special steel joints and a steel tap to a moveable mercury reservoir. (2) A laboratory vessel standing in a mahogany trough over mercury, into which the gases can be sent for absorption purposes. (3) An explosion vessel, similar to but rather larger than that of the Dittmar apparatus, in which all explosions are carried out.

The measuring vessel is provided with a three-way glass tap having two parallel capillary branches, one of which goes to the laboratory vessel, the other to the explosion vessel; the junctions are rendered vacuum tight by a device of steel faces and a clamp similar to that introduced by Regnault.

The moist gases are measured by bringing them to a certain constant volume in A and then deducing their tension in terms of millimetres of mercury from the reading on the barometer, B. Since the gases in A are moist and the 'vacuum' in B is always kept saturated with

water vapour, it is obvious that, provided the temperature of the water surrounding A and B remain constant throughout an analysis, none of the usual corrections for temperature, tension of water vapour, &c., need be applied to the analytical figures, as differences in readings on the barometer, under these conditions, correspond to differences in volume in the gases measured.

DISCUSSION.

Professor McLEOD thought that too much credit was ascribed to him for the gas-analysis apparatus, which was only a modification and simplification of that devised by Sir Edward Frankland. He had done away with the centre filling tube, so that a narrower glass cylinder which could be closed by an india-rubber plug was sufficient, thus avoiding complicated metal work; he had also lengthened the barometer, and thought that the author diminished the accuracy of his apparatus by making the barometer and measuring tube of the same length. All the stopcocks were made of glass, which seemed preferable to steel, as any leakage could be more easily detected and remedied. One small part of the apparatus he did claim, and that was the suspended globular mercury reservoir, and he was gratified to see that this simple device was in use in very many forms of apparatus in which mercury is employed.

Mr. G. N. HUNTLY said that he had been working for some time with a slightly modified form of the Frankland apparatus, in which the black glass points of Joly were used instead of lines etched round the tube. The accuracy of this method of reading is so great that a tube of one inch diameter can be used without loss of precision. The author's experience with the Dittmar-Lennox pipette did not agree with his own, as experiments made with a view of testing these pipettes showed that 5 c.c. of gas, measured initially at atmospheric pressure, could be transferred backwards and forwards repeatedly without the readings on the barometer tube differing by more than 0.1 mm., an accuracy of 1 in 7000. With careless working, transference tended, not to a loss of gas as the author suggested, but to a gain, minute air bubbles being introduced apparently from the fingers.

*92. "Preliminary note on the action of light on acetylene." By William A. Bone and John Wilson.

Some time ago the authors noticed that acetylene undergoes a well marked change on exposure to bright sunlight. Tubes of about 100 c.c. capacity drawn out at each end and terminated by capillary glass taps were filled at atmospheric pressure with pure acetylene prepared from copper acetylide and dried by passing through a concentrated solution of potassium hydroxide. Some of these tubes were exposed on the

roof of the laboratory throughout June and July of last year when the weather was particularly fine. After two or three days' exposure, a faint brown deposit was observable on the inside of the bulbs. This gradually increased in extent and thickness until, at the end of a fortnight, the tubes were entirely covered with a dark brown, greasy deposit. The change was evidently due to the action of sunlight, for if a portion of the tube were screened from the light, no deposit was formed over the area so protected, and, further, after the tube had become coated with the opaque deposit no further action was noticeable even after prolonged exposure. Acetylene was decomposed to a less extent when exposed in tubes during August and September, 1897, than during the previous two months. The decomposition is independent of the presence of air, because acetylene mixed with its own volume of oxygen or nitrogen was exposed to sunlight for a very long period without any appreciable change occurring.

A slight contraction in volume was observed when tubes exposed during last summer were opened over mercury. A measured quantity of the gas sent into a Hempel pipette containing a freshly prepared ammoniacal solution of cuprous chloride was quickly reduced to about 2 per cent. of its original volume. The residual gas, after treatment with dilute sulphuric acid, appeared to contain a fairly dense hydrocarbon absorbed by fuming sulphuric acid, mixed possibly with a small quantity of hydrogen; no saturated hydrocarbon could be detected.

The solid deposit on the side of the tube was removed by treatment with fuming nitric acid, in which it does not dissolve to any appreciable extent. On removal of the acid by filtration, irregular, yellow plates remained. The acid filtrate was carefully tested for the presence of nitro-derivatives of benzene and naphthalene, but without success. The yellow plates were insoluble in hot benzene and could be heated at 270° without melting or undergoing any change; they apparently consisted of a very dense hydrocarbon or hydrocarbons.

The authors are working this summer on larger volumes of acetylene, and hope eventually to determine the nature of the products obtained.

***93. "Reversible zymohydrolysis." By Arthur Croft Hill, B.A.**

This investigation was undertaken to ascertain whether zymohydrolysis is a reversible process or not. The hydrolysis of maltose by maltase was selected for the purpose, the enzyme being obtained by extracting dry and finely powdered low-fermentation yeast, which had been heated under certain precautions, as detailed in the paper. It was found that the extract could be sterilised without destruction of its activity by filtration through a Pasteur-Chamberland filter.

The analytical methods for estimating the extent of hydrolysis were (1) determination of the cupric-reducing power of the mixed sugars; (2) determination of the specific rotatory power. The details of the methods and limits of accuracy are dealt with fully in the paper. To simplify calculations, maltose is reckoned as maltose hydrate, $C_{12}H_{22}O_{11} \cdot H_2O$.

The zymohydrolysis of maltose into glucose is hindered by the presence of glucose and is incomplete, and both these effects are more marked the more concentrated the solution of sugar. The retardation is shown by two sets of experiments. In the first set, the initial velocities of conversion are compared in a solution of maltose of a certain concentration with that in a solution of half maltose and half glucose of like total concentration. The ratio of these velocities should be not greater than 2, if the glucose were without influence; actually it is much greater, being about 3 for a 4 per cent., and 4.85 for a 20 per cent. sugar concentration. In the second set, the time curves are compared for two flasks, each containing initially the same concentration of maltose, while to one glucose has been added in equal concentration. If glucose were without influence, the time curve of conversion of maltose into glucose should be identical for each flask, but a much slower conversion occurs in that containing the added glucose, and the effect is much more marked with a total sugar concentration of 20 per cent. than with one of 4 per cent.

When the enzyme acts in a 20 per cent. solution of glucose, a small reverse action can be detected by the polarimeter. With a 40 per cent. concentration, the reverse action is well marked, and when sufficient time has been allowed for this action, which is a slow one, to approach completion, the reversion indicated by the change in rotatory and cupric-reducing powers amounts to 15 per cent. of the sugar. Control flasks show no change. With a 40 per cent. solution of sugar, of which 75 per cent. was glucose and 25 per cent. maltose (hydrate), hydrolysis proceeded till 83.25 per cent. of the total sugar was glucose, and the equilibrium point, therefore, for this concentration is not far from 84 parts glucose to 16 parts maltose (hydrate). Equilibrium points for various concentrations have been determined; and it is found that in dilute (2 per cent.) solutions hydrolysis is practically complete. The same equilibrium point is approached either with a solution of maltose or with one of glucose of the same concentration.

Maltose has been detected as a product of the reverse action by the use of phenylhydrazine. An osazone having a greater solubility in boiling water than glucosazone has been separated, and this crystallises in plates, has the same percentage of carbon and nitrogen as maltosazone, but melts at a temperature somewhat lower than maltosazone from pure maltose, though not lower than that prepared from ordinary maltose under similar conditions, viz., from a mixture of

maltose with excess of glucose to which some boiled enzyme solution has been added, the proteid being then removed as completely as possible before treatment with phenylhydrazine. The synthesised maltose has not yet been isolated, but it is considered that the evidence of its presence, coupled with the increase of optical rotatory power and corresponding decrease in cupric-reducing power observed in concentrated glucose solutions in the presence of maltase, justify the conclusion that the zymohydrolysis of maltose is a reversible process.

DISCUSSION.

Dr. HORACE BROWN congratulated the author on the important results he had obtained, and stated that, although some such reversed action was recognised when dextrose is acted on by dilute acids, this was the first time that anything of the kind had been shown to occur during prolonged enzyme action. He had been privileged to see the details of the author's work whilst it was in progress, and was quite satisfied that a reversal had really taken place. The alteration in optical and reducing properties, and the appearance of the osazone pointed strongly to the reversed product being ordinary maltose, but until this was isolated, and such isolation ought not to present any insuperable difficulties, he did not feel quite satisfied as to its nature. It could not be identical, however, with the isomaltose obtained by Emil Fischer by the action of acid on dextrose.

Mr. LING thought that additional evidence was necessary before it could be definitely concluded that maltose was produced from glucose, and, as a possible means of deciding the question, suggested converting the product into acetyl derivatives instead of into osazones. Octacetyl-maltose was a well characterised compound, and could, he thought, be separated from the acetyl derivatives of glucose.

94. "The solubility of isomeric substances." By James Walker Ph.D., D.Sc., and John K. Wood, B.Sc.

In continuation of a research by Carnelley and Thomson (*Trans.*, 1888, 53, 782), the authors have investigated the solubility of the hydroxybenzoic acids, and the isomeric ureas, $C_7H_5N \cdot CO \cdot NH_2$, in various solvents.

The values obtained for the solubility of salicylic acid at different temperatures are one-third less than the values given by Bourgoin. The variation of the solubility of the hydroxybenzoic acids in water with the temperature is expressible up to 50° by a formula of the type proposed by Nordenskjöld, the equations being, for the ortho-acid, $\log S = 0.01556t - 1.0458$; for the meta-acid, $\log S = 0.01793t - 0.4188$; and for the para-acid, $\log S = 0.0227t - 0.7972$. With benzene as

solvent, a formula of this type does not express the variation of the solubility with the temperature.

Congo red was found to be the best acidimetric indicator for salicylic acid and its isomerides.

The rule that the order of fusibility of isomeric substances is also the order of their solubility does not hold good for the hydroxybenzoic acids, but it is in general applicable to benzyl urea and its isomerides.

The rule that the order of solubility of isomerides is independent of the solvent is not strictly applicable in either of the cases investigated. The constancy of the solubility ratio observed by Carnelley and Thomson for para- and meta-nitraniline is not found either with the acids or with the ureas. The solubility ratios of the hydroxybenzoic acids in the same solvent vary considerably with the temperature.

95. "Note on nitration and substitution in nitro-compounds."

By Arthur Lapworth, D.Sc., and Charles Mills.

It is known that (1) nitro-compounds yield chiefly meta-derivatives with most substituting agents, but orthonitrophenols when acted on by alkaline ferricyanide; (2) ortho- and para-chloronitrobenzene form the corresponding nitrophenols by interaction with alkalis, whilst the meta-compound is not affected; (3) ortho- and para-ethoxynitrobenzene are converted into the corresponding nitranilines on treatment with ammonia, but the meta-derivative is not affected. The authors consider that these facts are in complete accordance with the view of substitution advocated by one of them (*Trans.*, 1898, 73, 445), namely, that substitution in nitro-compounds is largely due to the occurrence of successive, irreversible, desmotropic changes in products formed by the addition of the acting agent to the side group.

In the hope of showing that when acid oxidising agents act on nitro-compounds, ortho- or para-nitrophenols, if any, would be produced, the authors undertook the investigation of an acid substance formed under certain conditions during the nitration of toluene. As ortho- and para-nitrotoluenes are the chief products of that reaction, it was thought probable that this substance had been formed from one of these. Examination showed, however, that oxidation of toluene had doubtless been the first action, as the substance was identified as dinitroparacresol [$\text{Me}:\text{OH}:(\text{NO}_2)_2 = 1:4:3:5$], and thus contained both nitro-groups in meta-positions relatively to the methyl radicle.

96. "Hydroxydibromocamphorsulphonic acid. A correction." By Arthur Lapworth, D.Sc., and F. Stanley Kipping, D.Sc., F.R.S.

In a paper on "Sulphocamphoric acid and other derivatives of camphorsulphonic acid" the authors described as "hydroxydibromo-

camphorsulphonic acid, $C_{10}H_{14}Br_2SO_5$," a compound obtained by oxidising ammonium α -bromocamphorsulphonate with nitric acid (*Trans.*, 1897, 71, 19). This composition was assigned to the oxidation product in question, partly from the results of analyses, partly from the study of a well-defined crystalline sulpholactone, $C_{10}H_{12}Br_2SO_4$, which was obtained simultaneously with the acid, and into which the acid was found to be convertible under certain specified conditions. At the same time, it was admitted that no direct evidence of the presence of a hydroxyl group in the acid had been obtained, and that, although the conversion of the acid into the lactone had been accomplished, the method by which this change was brought about was difficult to explain.

Further investigation has shown that the supposed "hydroxy-acid, $C_{10}H_{14}Br_2SO_5$," is in reality a *hydrated dibromocamphorsulphonic acid*, $C_{10}H_{14}Br_2SO_4 \cdot H_2O$, so that its conversion into the lactone by the process employed (boiling with aqueous silver nitrate) is now explained as a simple oxidation followed by elimination of the elements of water. The analyses already referred to gave results agreeing just as well with those required by the new ($C=29.4$; $H=3.9$; $Br=39.2$; $S=7.8$ per cent.) as with those calculated for the original formula, and further analyses have given equally satisfactory results ($C=29.7$; $H=3.8$; $Br=39.4$). The *anhydrous acid* was only obtained with difficulty owing to the water of crystallisation in the hydrated compound being very obstinately retained; it crystallised from petroleum and ether in slender prisms melting with decomposition at $245-252^\circ$, and on analysis gave the following results ($C_{10}H_{14}Br_2SO_4$ requires $C=30.8$; $H=3.6$; $Br=41.0$. Found $C=30.5$; $H=3.6$; $Br=41.2$ per cent.).

One of the authors has now obtained the acid by a method which confirms this view of its composition, and its investigation is being continued.

97. "Enantiomorphism." By F. Stanley Kipping, D.Sc., F.R.S., and William Jackson Pope.

The authors have previously shown (*Proc.*, 1896, 12, 249) that, on crystallising the cubic tetartohedral sodium chlorate from aqueous solutions containing various optically active carbohydrates, the two enantiomorphously related crystalline forms of sodium chlorate are deposited in different numbers; numerical data respecting the ratios of the numbers in which dextro- and laevo-crystals of sodium chlorate separate from solutions containing dextroglucose, mannitol, dulcitol, and isodulcitol are now given. A saturated solution of sodium chlorate containing 200 grams of *d*-glucose per litre deposits on crystallisation

an average of 31.75 per cent. of dextro- and 68.25 per cent. of lævo-crystals of sodium chlorate by number ; results showing that a similar enantiomorphous influence is exercised on the crystallisation of sodium chlorate by other carbohydrates are also given.

Data have also been obtained respecting the proportion in which dextro- and lævo-crystals of sodium chlorate separate from pure aqueous solutions ; the examination of a large number of crops of crystals shows that 50.03 ± 0.11 per cent. of the deposited crystals are dextrorotatory.

98. "Azobenzene derivatives of chrysin, euxanthone, gentisin, and morin." By A. G. Perkin.

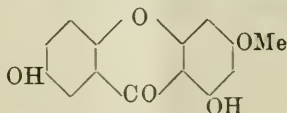
It has been previously shown that apigenin, the colouring matter of parsley, *Apium petroselinum* (*Trans.*, 1897, 71, 805), forms a disazo-derivative, and that during its purification with nitrobenzene and acetic acid a bye-product is obtained, which is evidently an acetyl compound (*Proc.*, 1897, 13, 54). Thus prepared, the latter is apt to be impure, and is best formed by the prolonged digestion of disazobenzenepigenin with boiling acetic anhydride. It forms orange-red needles melting at $277-280^\circ$ when rapidly heated, and in general properties is almost indistinguishable from the disazo-compound itself.

Chrysin, the colouring matter of poplar buds, yields a *disazo*-derivative, $C_{15}H_8O_4(N_2Ph)_2$, which crystallises in orange-coloured needles, melts at $250-252^\circ$, and is insoluble in alkaline solutions. It contains no free hydroxyl groups.

The diazobenzene groups in these compounds are thus adjacent to the two hydroxyl radicles of the phloroglucinol nucleus, and the results harmonise with previous work which indicated that apigenin is a hydroxychrysin.

Euxanthone, derived from the Indian dye-stuff "purree," yields *disazobenzen-euxanthone*, $C_{13}H_6O_4(N_2Ph)_2$, which crystallises in brick-red needles, melts at $249-250^\circ$, and is almost insoluble in alkalis. Acetic anhydride converts it into a *diacetyl* compound, $C_{13}H_4O_4Ac_2(N_2Ph)_2$, which forms olive-coloured needles and melts at $197-199^\circ$.

From gentisin, *disazobenzenegentisin*, $C_{14}H_8O_5(N_2Ph)_2$, is obtained. This crystallises in orange-red needles, melts at $218-220^\circ$, and yields a *diacetyl* derivative, $C_{14}H_6O_5Ac_2(N_2Ph)_2$. These results indicate that the methoxyl group in gentisin has the following position :



Disazobenzenemorin, $C_{15}H_8O_4(N_2Ph)_2$, a red-brown, crystalline pow-

der, is formed in very small quantity by the interaction of diazobenzene sulphate with morin in alkaline solution. No trisazo-compound could be obtained.

99. "Constituents of the Indian dyestuff 'waras.'" By A. G. Perkin.

Waras is a purplish powder which covers the seed pods of *Flemingia congesta*, an erect, woody shrub of Africa and India. In its general properties and microscopic appearance it closely resembles kamala (*Mallotus Phillipinensis*) previously investigated (*Trans.*, 1893, **63**, 975; 1894, **65**, 232). For the supply of material, which is very difficult to procure, the author is indebted to the authorities of the Imperial Institute.

Flemingin, $C_{12}H_{12}O_3$, the principal crystalline constituent, was obtained as an orange-red powder consisting of small, prismatic needles melting at $171-172^\circ$. In appearance and numerous properties it resembles the rottlerin of kamala, but is distinguished from this by its solubility in alcohol, and by the browner tint of its alkaline solutions. In an alkaline bath, it dyes silk a golden yellow, and is a stronger dyestuff than rottlerin. On fusion with alkali, it gave acetic acid, salicylic acid, and an acid of higher melting point which was not identified.

Homoflemingin ($C = 69.97$; $H = 5.75$), present only in minute quantity, forms glistening, yellow needles, melts at $164-166^\circ$, and possesses properties resembling those of flemingin.

The *resin of high melting point*, $C_{12}H_{12}O_3$, forms a brick-red powder soluble in alkali, with a deep brown tint, and yields acetic and salicylic acids on fusion with alkali. It dyes silk in shades which are redder than those produced by flemingin.

The *resin of low melting point*, $C_{13}H_{14}O_3$, is a deep orange-brown, transparent mass which melts below 100° , is soluble in alkali with an orange-brown colour, and closely resembles the resin of low melting point of kamala. On fusion with alkali, acetic and salicylic acids are obtained, and on boiling with nitric acid (sp. gr. 1.5) oxalic acid is formed.

From numerous characteristic reactions described in the paper, it is concluded that the above substances are closely related to, though not identical with those present in kamala.

Waras dyes silk a golden yellow shade, and is a much stronger dye-stuff than kamala.

100. "Note on the oxidation of charcoal by nitric acid." By G. Dickson, M.A., and T. H. Easterfield, M.A., Ph.D.

Well-burnt charcoal reacts readily with fuming nitric acid, the action being accompanied by a considerable rise of temperature. When boiled for 24 hours with fuming nitric acid, the charcoal goes entirely into solution, and on dilution with water a black, amorphous substance is precipitated, whilst mellitic and non-crystalline acids remain in solution. The black, amorphous substance resembles the "mellogen" of Bartoli and Papasogli (*Gazz.*, 1882, 12, 117); it is easily soluble in alkali, and on oxidation by alkaline permanganate yields oxalic and mellitic acids in about equal proportions.

From charcoal, 25 per cent. of its weight of crystalline ammonium mellitate can be obtained by the following process. The charcoal is boiled with fuming nitric acid for 24 hours and further oxidised by adding potassium chlorate to the boiling solution; the organic acids, after precipitation as barium salts, are converted into ammonium salts. The yield of mellitic acid varies only slightly, whether the charcoal contains 2 or only 0.2 per cent. of hydrogen. Coal under similar conditions gives only a small yield of mellitic acid.

Even nitric acid of sp. gr. 1.1 can oxidise well-burnt charcoal. After boiling continuously for seven days, the charcoal is changed to a black, impalpable mud, soluble in alkali. The nitric acid solution contains mellitic but no oxalic acid.

ADDITIONS TO THE LIBRARY.

I. *Donations.*

British Pharmacopœia, The. Pp. xxxii + 535. London 1898.

From the General Medical Council.

Lupton, Sydney. Notes on Observations; being an outline of the methods used for determining the meaning and value of quantitative observations and experiments in Physics and Chemistry, and for reducing the results obtained. Pp. ix + 126. London 1898.

From the Author.

II. *By Purchase.*

Jones, H. C. The Freezing Point, Boiling Point, and Conductivity Methods. Pp. vii + 64. Easton, Pa., 1897.

Mez, C. Mikroskopische Wasseranalyse. Anleitung zur Untersuchung des Wassers mit besonderer Berücksichtigung von Trink- und

Abwasser. Pp. xvii + 631. Mit 8 lithographischen Tafeln und in den Text gedruckten Abbildungen. Berlin 1898.

Ryn, W. van. Die Stereochemie des Stickstoffs. Gekrönte Preisschrift von der Universität Zürich. Pp. 148. Zürich 1897.

Threlfall, R. On Laboratory Arts. Pp. xii + 338. London 1898.

BANQUET TO PAST PRESIDENTS.

The Banquet to Past Presidents, unavoidably postponed from June 9th, has been finally fixed by the Council for Friday, November 11th.

COLLECTIVE INDEX.

The Collective Index for 1883—1892 is ready for distribution to Fellows who joined the Society prior to December 31st, 1892, and notified to the Assistant Secretary before December 31st, 1895, their wish to receive a copy.

Fellows who are ineligible to receive copies *gratis*, and those who may have neglected to apply for them prior to December 31st, 1895, may obtain the Index from the Assistant Secretary at the price of 15s., or 16s. including carriage.

Non-members may obtain copies from Messrs. Gurney and Jackson, 1, Paternoster Row, E.C., at the price of £1, excluding carriage.

Supplementary title pages are furnished to those who may wish to bind the Index of Authors and Index of Subjects as separate volumes.

The Collective Index for 1873—1882 is in course of preparation, and will be published during the next Session.

LIBRARY.

The Library will be closed during the last fortnight in August for cleaning and for the annual revision of the Catalogue. Fellows are requested to return all books in their possession not later than August 8th.

PROCEEDINGS
OF THE
CHEMICAL SOCIETY.
EDITED BY THE SECRETARIES.

No. 198.

Session 1898-9.

The following are the abstracts of papers received during the vacation and published in the *Transactions*:—

101. "The vapour pressures, specific volumes, and critical constants of normal heptane." By Sydney Young, D.Sc., F.R.S.

The critical constants of the specimen of normal heptane obtained by Dr. Thorpe from *Pinus sabiniana* are:—temperature, 266.9° ; pressure, 20415 mm.; volume of a gram, 4.266 c.c.

A comparison of the ratios of the absolute temperatures (boiling points) and volumes (liquid and saturated vapour) to the critical constants with those of normal pentane and normal hexane at "corresponding" pressures, shows that, whilst the deviations from constancy are small, the temperature ratios are certainly, and the volume ratios are probably, related to the molecular weights of the paraffins, but a full discussion of this relationship is reserved until the data for normal octane have been obtained.

102. "Contributions to the chemistry of phenol derivatives." By Raphael Meldola and Frederick Henry Streatfeild.

When phenol is brominated in acetic acid solution with one molecular proportion of bromine, and the product afterwards nitrated, a mixture of 4-bromo-2-nitrophenol and 2-bromo-4:6-dinitrophenol is always obtained (*Trans.*, 1896, 69, 1326). In the present paper, the authors show that the bromodinitrophenol is the result of the nitration of both the para- and ortho-bromophenols present in the crude product. The presence of orthobromophenol is proved by the formation of 2-bromo-4-nitrophenol, which the authors have succeeded in isolating from the mixture of nitro-derivatives. The formation of 2-bromo-4:6-dinitrophenol from parabromophenol is not due to

"isomeric change" as ordinarily understood, since the first product of the nitration of 4-bromo-2-nitrophenol under the conditions of nitration employed is 4-bromo-2:6-dinitrophenol, and this undergoes isomeric change only when heated with bromine and water (Armstrong, *Trans.*, 1875, 28, 520), or nitric acid (Gordon, *Proc.*, 1891, 7, 64), or at ordinary temperatures when the solution in excess of fuming nitric acid is allowed to stand for about two hours. The statement of Hübner and Brenken (*Ber.*, 1873, 6, 170) that when phenol is brominated in acetic acid and the solid (para) bromophenol frozen out a liquid isomeride in the mother liquor remains, is thus confirmed. At the same time, the suspicion expressed by Armstrong (*loc. cit.*, 521) that pure parabromophenol gives some "bromo-*a*-dinitrophenol" on nitration, is also confirmed.

The authors have also studied the products of the nitration of pure orthobromophenol. These are 2-bromo-4-nitrophenol (m. p. 112°) and 2-bromo-6-nitrophenol, a new modification (m. p. 67—68°), of which the silver, barium, potassium, and methyl salts are described.

On limited reduction, 4-bromo-2:6-dinitrophenol yields 4-bromo-2-nitro-6-aminophenol (m. p. 141—142°), from which the acetyl derivative (m. p. 161—162°), the methyl ether (m. p. 81—82°), and 4-bromo-2:6-dinitraniline were prepared.

The following derivatives of guaiacol were also obtained: 4-bromo-2-nitroguaiacol (m. p. 103—104°), 2-bromo-4-nitroguaiacol (m. p. 142°), and acetamidoguaiacol [$\text{OH} : \text{OMe} : \text{NHAc} = 1 : 2 : 6$], crystallising from water with $1\text{H}_2\text{O}$, which is lost at 100°.

103. "Some iodoso-compounds." By John McCrae, Ph.D.

In order to ascertain whether diortho-substituted phenylic iodides yield dichlorides and iodoso-derivatives, the behaviour of orthiodo-dimetadibromotoluene and symmetrical tribromiodobenzene was investigated. The dichlorides were not obtained quite so easily as in the cases of simpler iodides, but this is due to the fact that the iodide dichlorides of these two compounds are more easily soluble in chloroform than the iodides themselves; consequently the dichlorides did not separate until some of the chloroform had evaporated. The dichloride, iodoso-, and iodoxy-derivatives of 5-nitro-2-iodotoluene were also prepared.

104. "On myrticolorin, the yellow dye material of *Eucalyptus* leaves." By Henry G. Smith.

Myrticolorin, $\text{C}_{27}\text{H}_{28}\text{O}_{16}$, exists in large quantity in the leaves of the "Red Stringy Bark," *Eucalyptus macrorhyncha*, and is a new glucoside of quercetin occupying an intermediate position between

osyritrin, $C_{27}H_{30}O_{17}$, obtained from the Cape sumach (A. G. Perkin, *Trans.*, 1897, 71, 1132), and Viola quercitrin, $C_{27}H_{26}O_{15}$, from the flowers of *Viola tricolor variensis*.

The sugar gave an osazone melting with slight decomposition at 180° when slowly heated, and at 190° with rapid decomposition when rapidly heated. As the osazone of galactose is indicated by these results, and as manna containing sugars is not obtained from the group of Eucalypts to which *E. macrorhyncha* belongs, whilst the principal sugar of the members of the group which do exude manna is raffinose, the question becomes one of importance, and the sugar of myrticorin will be further examined.

In colour, melting point, reactions with reagents, and dyeing power, no differences could be detected between myrticorin and osyritrin, a specimen of which had been forwarded by Mr. A. G. Perkin for comparison.

105. "Chemical properties of concentrated solutions of certain salts. Part II. Double potassium succinates." By William Colebrook Reynolds.

The result of the addition of many metallic salts to a concentrated solution of potassium succinate resembles that obtained with a concentrated solution of potassium carbonate (*Trans.*, 1898, 73, 262). Crystalline double succinates, more or less soluble in the solution, were obtained instead of the insoluble metallic succinates in the case of nickel, zinc, cobalt, lead and calcium.

106. "Additive compounds of organic bases and ethereal salts of unsaturated acids." By S. Ruhemann and K. C. Browning.

The authors have found that the view expressed by Ruhemann and Hemmy (*Trans.*, 1897, 71, 334) with respect to the mode of formation of the compound regarded provisionally as triethylic anhydro-oxal-aconitate is correct, as ethylic oxalacetate alone takes part in the reaction. Whilst endeavouring to determine the constitution of that substance, they have observed that piperidine forms additive compounds with ethereal salts of unsaturated acids. These distil in a vacuum without decomposition, have basic properties, and form hydrochlorides which are very soluble in water. The following additive compounds are described: ethylic piperidylsuccinate (b. p. 159° at 10 mm.), ethylic piperidylpyrotartrate (b. p. $163\text{--}164^\circ$ at 10 mm.), ethylic piperidyltricarallylate (b. p. $201\text{--}202^\circ$ at 10 mm.), and ethylic piperidylcinnamate (b. p. $220\text{--}221^\circ$ at 11 mm.).

107. "Formation of ethereal salts of β -ketonic acids." By S. Ruhemann and K. C. Browning.

Adopting Michael's method for the formation of ethereal salts of β -ketonic acids by the combination of ethylic sodio-acetoacetate with the ethylic salts of unsaturated acids, the authors have prepared ethylic α -acetotricarballylate (b. p. 187—188° at 11 mm.), ethylic acetoethyltricarballylate (b. p. 194—196° at 9 mm.), ethylic α -benzoyltricarballylate (b. p. 244—245° at 10 mm.), and ethylic α -acetobutanetetracarboxylate (b. p. 222—223° at 10 mm.).

108. "Disulphonic acids of toluene, of ortho- and para-toluidine, and of ortho- and para-chlorotoluene." By William Palmer Wynne, D.Sc., F.R.S., and James Bruce, B.Sc.

The authors correct certain errors which occur in their previous communication (*Proc.*, 1895, 11, 153), and show that the paratoluidinedisulphonic acids obtained by Richter from the 1:4:3- and 1:4:2-paratoluidinesulphonic acids (*Annalen*, 1885, 230, 314, 331) are the 1:4:3:5- and 1:4:2:5-derivatives respectively. They also show that the toluenedisulphonic acid previously described as the 1:2:6-derivative is the 1:2:5-compound.

Paratoluidine-3:5- and -2:5-disulphonic acids, and orthotoluidine-3:5- and -4:5-disulphonic acids, together with the corresponding chloro-acids, are described, and the statements of Hasse (*Annalen*, 1885, 230, 286) with respect to the bromotoluenedisulphonic and toluenedisulphonic acids derived from orthotoluidine-3:5-disulphonic acid are shown to be erroneous.

Parachlorotoluene-3- and -2-sulphonic acids, and orthochlorotoluene-4-sulphonic acid, together with the disulphonic acids derived from them by further sulphonation, are described, and the conclusion is drawn that the mixture of monosulphonic acids obtained on sulphonating parachlorotoluene contains not more than 14 per cent. of the 1:4:3-isomeride.

Incidentally, the list of six toluenedisulphonic acids given by Klason (*Ber.*, 1887, 20, 350) has been revised, and it is shown that only five of the six acids theoretically possible are known. Experiments are in progress with the object of obtaining the missing 1:2:3-isomeride.

109. "Chlorine derivatives of pyridine. Part II. Interaction of ammonia and pentachloropyridine. Constitution of glutazin." By W. T. Sell, M.A., and F. W. Dootson, M.A.

The authors describe the preparation from pentachloropyridine of γ -amidotetrachloropyridine, (presumably α -) amidotetrachloropyridine,

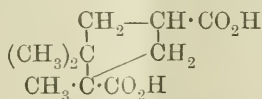
diamidotrichloropyridine, and hydroxytetrachloropyridine. γ -Amido-tetrachloropyridine is identical with the compound obtained by Stokes and Pechmann (*Ber.*, 1887, 20, 2655) from glutazin, and thus demonstrates the presence of an amido-group in the latter substance.

110. "Mercury acetamide." By M. O. Forster, Ph.D., B.Sc.

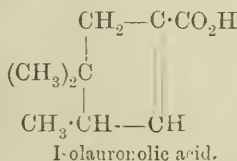
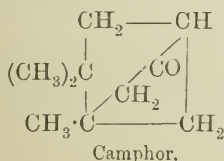
Mercury acetamide liberates nitrogen from hydroxylamine, hydroxylamine hydrochloride, hydrazine, hydrazine hydrochloride, and phenylhydrazine, being resolved by these substances into acetamide and mercury, which, in the case of the salts mentioned, are accompanied by calomel; the products from phenylhydrazine are aniline, benzene, and mercury diphenyl. Phenylhydroxylamine is converted into nitrosobenzene and azoxybenzene by the agency of mercury acetamide, which transforms hydrazobenzene into azobenzene. Nitrosophenylhydroxylamine, aniline, and diazoamidobenzene yield additive compounds with mercury acetamide.

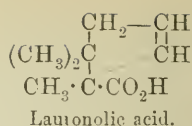
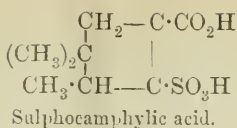
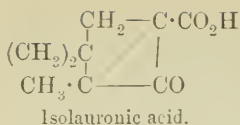
111. "Sulphocamphylic acid and isolauronolic acid, with remarks on the constitution of camphor and of some of its derivatives." By W. H. Perkin, jun.

In this communication, the author shows that the results which he and others have obtained in the investigation of isolauronolic acid can, apparently, be explained only on the assumption that camphoric acid has the formula



With the aid of this formula, the oxidation of isolauronolic acid, $\text{C}_9\text{H}_{14}\text{O}_2$, to isolauronic acid, $\text{C}_9\text{H}_{12}\text{O}_3$, and further to γ -acetyldimethylbutyric acid, $\text{CH}_3 \cdot \text{CO} \cdot \text{C}(\text{CH}_3)_2 \cdot \text{CH}_2 \cdot \text{CH}_2 \cdot \text{CO}_2\text{H}$, is readily understood. Assuming that the above constitution for camphoric acid is correct, the author deduces the following formulæ as probably representing the constitution of some of the more important members of the camphor group:—





These formulæ are shown to explain the properties of the substances in a satisfactory manner.

112. "Researches on the terpenes. VIII. On carvenol: its reactions and products." By J. E. Marsh and A. Hartridge.

Carvenol, the product of the action of strong sulphuric acid on chlorocamphene, and previously described as hydroxycamphene or camphenol (*Trans.*, 1897, 71, 290), has been further examined. It has been found to yield chlorocymene [$\text{Me} : \text{Cl} : \text{Pr}^\beta = 1 : 2 : 4$] by the action of phosphorus pentachloride, and paracymene by the action of benzoic chloride. It is reduced by sodium in alcoholic solution, forming the secondary alcohol *carvanol*, $\text{C}_{10}\text{H}_{20}\text{O}$, which is hexahydrocarvacrol. This latter compound yields, on oxidation, the saturated ketone *carvanone*, $\text{C}_{10}\text{H}_{18}\text{O}$.

The production from camphor of cymene and chlorocymene by comparatively simple reactions, and also of reduced cymene derivatives, brings into prominence the close relationship which must exist between camphor and cymene. Not only do formulæ which fail to express this relationship in the arrangement of the carbon atoms lose the chief support on which any formula for camphor must rely, but, further, in view of the production of chlorocamphene, a saturated compound, no formula can be admitted which leads to the representation of camphene and chlorocamphene as unsaturated compounds.

113. "Optically active alkyloxypropionic acids." By Thomas Purdie, F.R.S., and G. Druce Lander, B.Sc.

As the product of the action of isopropyl iodide on inactive silver lactate contains a considerable quantity of isopropyl isopropoxypropionate (*Trans.*, 1898, 73, 296) the authors concluded that the abnormally high rotation of the active ethereal lactates prepared by the silver salt method (*Trans.*, 1895, 67, 916; 1896, 69, 830) was due to their contamination with small quantities of active ethereal alkyloxypropionates. If this conclusion is correct, the alkyloxypropionic acids must be substances of very high optical activity. With the view of verifying this, the active α -methoxy-, ethoxy-, and propoxypropionic acids have been prepared.

As complete racemisation occurs during the action of sodium

ethylate on active ethylic chloro- and bromo-propionates (*Trans.*, 1896, 69, 819), the active alkyloxy-acids were prepared by the resolution of the inactive acids with alkaloids. The resolution of ethoxypropionic acid was carried out with cinchonidine, and more completely with morphine, the salt of the dextro-acid being in both cases the less soluble. The methoxy- and propoxy-acids were also resolved with both alkaloids, but the resolution with cinchonidine was far from complete. In the case of the methoxy-acid, both alkaloids precipitate first the lævo-acid; in the case of the propoxy-acid, the cinchonidine salt of the lævo- and morphine salt of the dextro-acid are first deposited. The authors point out that the results of their experiments are not in harmony with the theory of Winther (*Ber.*, 1895, 28, 3000).

Polarimetric observations were made on the *l*-methoxy-, *d*-ethoxy- and *d*-propoxy-acids, and on their sodium and calcium salts, also on barium and silver *d*-ethoxypropionates. The substitution of the alcoholic hydrogen of the lactates by an alkyl group produces, as was expected, a great increase of optical activity. Thus the molecular rotation of the alkaline lactates in dilute aqueous solution is 14.5° , while that of sodium ethoxypropionate is 68.77° . Increase in the weight of the introduced alkyl group produces a very much smaller but still distinct rise of molecular rotation. The rotations of the salts increase with dilution, and in general conform to the law of Oudemans and Landolt; those of the acids diminish. The changes of rotation with varying concentration are, as might be expected from the disappearance of the hydroxyl group, of a more normal kind than in the case of lactic acid and the lactates, but the authors conclude that even in the case of the alkyloxy-acids, the rotation is influenced by other factors connected with the solvent besides electrolytic dissociation.

114. "The optical activity of gallotannic acid." By Otto Rosenheim Ph.D., and Philip Schidrowitz, Ph.D.

The authors have examined a number of commercial "pure" gallotannic acids and find that, whilst they varied in optical activity from $[\alpha]_D + 11^\circ$ to $[\alpha]_D + 74.2^\circ$, they all contain from 50 to 75 per cent. of a uniform gallotannic acid possessing an optical activity of approximately $[\alpha]_D + 75^\circ$. The authors ascribe this great difference to the fact that the commercial substances contain varying quantities of gallic acid, which is inactive, and mineral matter, which possesses a great influence on rotatory power. Acetyl derivatives and quinine salts prepared from the commercial samples are respectively identical in optical activity among themselves and with the products obtained from the homogeneous substance isolated by the authors' method.

115. "The influences modifying the specific rotatory power of gallotannic acid." By Otto Rosenheim, Ph.D., and Philip Schidrowitz, Ph.D.

The authors have examined the modifying influence of: (a) concentration, (b) nature of the solvent, and (c) optically inactive substances, on the specific rotation of gallotannic acid. The material used for these experiments was the homogeneous product obtained by methods described in the preceding paper. The results were as follows:—

(a) Concentration.—In aqueous solutions containing not more than one per cent., the rotation is constant at $[\alpha]_D^{25} + 75.2^\circ$. From 1 to 10 per cent., the rotation decreases gradually to $[\alpha]_D^{25} + 66.1^\circ$.

(b) Nature of the solvent.—The optical activity of gallotannic acid depends to a very marked extent on the nature of the solvent. Thus the original specific rotation $[\alpha]_D^{25} + 75.2^\circ$ (for water) is reduced to $\pm 0^\circ$ for a mixture of acetone and carbon tetrachloride. Alcohol, ethylic acetate, &c., and mixtures of acetone with ether, &c., have a powerful depressing action, and the gross effect produced is greater in the case of gallotannic acid than in that of any other substance hitherto examined.

(c) Influence of optically inactive substances.—(1) Acids.—Mineral acids have no influence. Acetic acid has a depressing effect, but this is probably due to partial acetylation. Gallic acid has no influence. (2) Ammonia.—A few drops added to a one per cent. solution produce total inactivity. (3) Salts.—Salts, such as sodium tungstate, sodium, potassium, ammonium and lithium bborates and chlorides, sodium and potassium bicarbonates, and zinc acetate, exercise a very marked influence on the rotation of gallotannic acid. In the majority of cases, the addition of increasing amounts of salt produces a decrease in the specific rotation until a minimum is attained, the further addition of salt causing a gradual rise. The molecular rotations of the mixtures at the minima are approximately constant and equal to the molecular rotation of gallotannic acid alone.

116. "The non-resolution of racemic tetrahydropapaverine by tartaric acid." By William Jackson Pope and Stanley John Peachey.

Prior to the publication of Goldschmiedt's paper (*Monats.*, 1898, 19, 321), the authors had prepared the dextrotartrate of racemic tetrahydropapaverine in the course of their work on the resolution of the base into its optically active components (*Proc.*, 1898, 14, 122). The salt has the composition assigned to it by Goldschmiedt, and belongs

to the monosymmetric system ; $a : b : c = 1.1464 : 1 : 0.7932$; $\beta = 82^\circ 30'$. Its molecular rotation was found to be $[M]_D = +63.44^\circ$, a value agreeing with those obtained for the metallic tartrates in dilute aqueous solution, namely, 58.1 to 64.6 (Landolt, *Ber.*, 1873, 6, 1077).

Ladenburg has described as "hemiracemic," salts in which either the acid or the base is racemic whilst the other constituent is optically active, and has examined two salts of the kind, namely, quinine racemic pyrotartrate (*Ber.*, 1898, 31, 524, 937) and strychnine racemate (*Ber.*, 1898, 31, 1969). Racemic tetrahydropapaverine dextrotartrate is thus the first case of the kind in which a racemic base is combined with an optically active acid.

November 3rd, 1898. Professor Dewar, F.R.S., President, in the Chair.

Messrs. L. M. Nash, A. J. Parker, W. A. Lethbridge, F. E. Weston, and W. C. Reynolds were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. Hugh Poynter Bell, 30 Egerton Crescent, S.W. ; Reginald Arthur Berry, The University Chemical Laboratory, Cambridge ; Thomas Henry Boardman, 4 St. George's Terrace, Wilton, Taunton ; Marston Taylor Bogert, 259 Broadway, Flushing, New York ; Arthur Brooke, 17 Cavendish Square, Hull ; Johannes Christian Brunnich, Agricultural College, Gatton, Queensland ; John Paul de Castro, Ford House, Redruth, Cornwall ; David Leonard Chapman, Hulme Hall, Plymouth Grove, Manchester ; William Samuel Crouch, Colombo, Ceylon ; Alfred Valentine Cunningham, Christ's College, Cambridge ; William Brown Davidson, 29 Bedford Street, Liverpool ; Samuel Dickson, The Kraal, Elm Road, New Maldon ; Francis Alfred Drake, Rivington and Blackrod Grammar School, Horwich, Lancs ; James Edward Ferguson, 26 Connaught Road, Stroud Green, N. ; John Naish Goldsmith, Rock House, Tunbridge Wells ; E. B. Hadley, The Green, Calne, Wilts ; John Haworth, 4 Horsdon Terrace, Tiverton, Devon ; Alexander Garden Hendry, 14 Avenell Road, London, N. ; George William Fraser Holroyd, 14 Kensington Garden Terrace, W. ; Walter Howe, 45 Spring Gardens, Bradford ; Thomas Hill-Jones, Eagle Wharf Road, London ; Reginald Arundale Kay, 7 The Causeway, Cambridge ; John Charles Mascarenhas, 35 Harold Road, Upton Park ; Thomas Arthur Nightscales, Tynemouth Street, Hull ; William Pollard, Hitchin, Herts ; John Armstedt Ray, jun., 15 Nassau Street, Dublin ; Edmund Milton Rich, 7 Therapia Road, Honor Oak, S.E. ; Gilbert Rigg, Tudor Villa, Bryn Road, Swansea ; Henry John

Rolfe, 8 Powis Square, Bayswater, W. ; Richard Seligman, 15 Queen's Gate Gardens, S.W. ; George Senior, Arwendon, Abergele, North Wales ; Samuel Smiles, jun., Fair Oak, Beckenham, Kent ; Benjamin Jordan-Smith, 42 King's Road, Reading ; Basil Steuart, Broxburn, near Edinburgh ; Ambrose Walton, Gledholt, Lower Broughton Road, Broughton ; John Henry Young, 115 Birmingham Road, Oldbury.

The PRESIDENT said that before passing to the ordinary business of the meeting, he desired, on behalf of those present, to express condolence with the family of the late Mr. J. A. R. Newlands in their bereavement. It was not the occasion to refer to the work of Mr. Newlands in detail ; everyone would recognise, however, that his name would always be associated with the progress of chemical thought in our time, and, happily, he had lived to witness the expansion of the idea contained in his law of octaves into one of the most comprehensive developments of modern chemical theory. As a tribute to his memory, it was proposed that an enlarged portrait of Mr. Newlands should be hung in the Society's rooms.

Of the following papers, those marked * were read.

***117. "Determination of the equivalent of cyanogen." By George Dean, B.A.**

An examination of the different values found for the atomic weight of nitrogen led to the attempt to deduce it in another way, viz., from the equivalent of cyanogen. A known quantity of dry silver cyanide, prepared by precipitation of dilute silver sulphate solution with dilute hydrocyanic acid, was dissolved in nitric acid, and the silver determined by finding what amount of pure potassium bromide was necessary for its complete precipitation. Stas's method of titration in a beam of yellow light was employed.

The weight of cyanide corresponding to the atomic weight of silver was thus found ; subtracting from this the atomic weight of silver, the equivalent weight of cyanogen was obtained. The result of the experiments performed was to give a value of 26.065. Thus cyanogen is added to those substances, *e.g.*, chlorine, bromine, iodine, &c., whose equivalents have been observed by direct comparison with silver. If the value 12.01 is assumed to be the atomic weight of carbon, that for nitrogen, calculated from the equivalent of cyanogen, is 14.055.

DISCUSSION.

The PRESIDENT referred to the great importance of determining atomic weights by indirect methods. In conjunction with Dr. Scott, he had estimated the molecular weight of triethylamine hydrobromide

by titrating purified triethylamine with hydrobromic acid (*Proc. R. S.*, 1883, 35, 347). The values obtained showed differences which were easily recognisable, the best determination giving 182.012, and the mean 182.089 for the molecular weight. This proved that triethylamine could not as yet be obtained sufficiently pure for the purpose of a determination comparable in accuracy with Stas's determination of the ammonium salts, but in spite of the relatively wide limits, it was possible to deduce the atomic weight of carbon from these values by a method entirely independent of the combustion of carbon as diamond, graphite, or carbonic oxide, on which all previous determinations of the atomic weight of carbon had been based. Thus, subtracting Stas's value for the molecular weight of ammonium bromide (98.032), the values for C_6H_{12} became 83.98 and 84.057 respectively, which lead to 11.981 and 11.993 as the atomic weight of carbon if Stas's value for hydrogen (1.008) be employed. Stas, curiously enough, had never deduced the atomic weight of hydrogen from his values for ammonium and nitrogen. The probable explanation of this was that he believed the deduced result, $O : H = 16 : 1.008$, to be far too high, being unable to reconcile it with the determination, $O : H = 16 : 1$, which Dumas obtained from the synthesis of water. If, however, the atomic weight of hydrogen be taken as unity, Stas's values for oxygen and nitrogen become 15.86 and 13.92 respectively, and it was to be remembered that, according to Lord Rayleigh, the densities of hydrogen and nitrogen were in the ratio of 1 to 13.898. Mr. Dean's experiments gave for the atomic weight of nitrogen a value slightly higher than this, and almost identical with that deduced by Stas for his synthesis of fused nitrate of silver. He hoped Mr. Dean would continue this important research.

***118. "The composition of American petroleum." By Sydney Young, D.Sc., F.R.S.**

An investigation has been made of the hydrocarbons in American petroleum boiling between, say, 25° and 115° , and evidence has been obtained of the presence of the following:—

Isopentane, b. p. 27.95° ; normal pentane, b. p. 36.3° ; pentamethylene, b. p. about 50° ; isohexane, b. p. about 61° ; normal hexane, b. p. 68.95° ; methylpentamethylene, b. p. about 72° ; benzene, b. p. 80.2° ; hexamethylene, b. p. 80.8° ; isoheptane, b. p. 90.3° ; normal heptane, b. p. 98.4° ; methylhexamethylene, b. p. about 102° ; toluene, b. p. 110.8° . Of these, the two pentanes and normal hexane have been obtained pure, normal heptane nearly so, and hexamethylene and isoheptane fairly pure. Miss E. C. Fortey, B.Sc., has obtained hexamethylene nearly pure from American and quite pure from Galician petroleum

(*Proc.*, 1898, 14, 103). It is not improbable that other isomeric hexanes, and, therefore, possibly heptanes, may be present, and there are indications of the existence of small quantities of dimethylpentamethylene in American petroleum. A comparison of the results obtained with American, Galician, and Russian petroleum shows that the same classes of hydrocarbons—paraffins, polymethylenes or naphthenes, and aromatic hydrocarbons—are present in the petroleum from all three sources, but that the relative amount of naphthenes and, in all probability, of aromatic hydrocarbons is greatest in Russian and least in American petroleum.

***119.** "The separation of normal and iso-heptane from American petroleum." By Francis E. Francis, B.Sc., Ph.D., and Sydney Young, D.Sc., F.R.S.

The heptanes cannot be separated in a pure state from petroleum by fractional distillation, owing to the presence of naphthenes with boiling points not sufficiently far removed from those of the two paraffins.

A large quantity of mixed heptanes containing naphthenes, obtained by the partial fractionation of American petroleum, was therefore brominated. Heptyl and isoheptyl bromides were separated by fractional distillation under reduced pressure with a twelve column dephlegmator, and were reduced in alcoholic solution by a copper-zinc couple, a small amount of saturated hydrochloric acid being added. The reduced hydrocarbons were purified as far as possible, but the quantities, especially that of isoheptane, were too small to admit of satisfactory fractionation.

The boiling points and specific gravities of both paraffins were determined, also the critical constants of normal heptane, and its vapour pressures and specific volumes at a few temperatures. The data are compared with those for Thorpe's specimens of normal and iso-heptane.

***120.** "The boiling points and specific gravities of mixtures of benzene and normal hexane." By D. Hamilton Jackson, M.A., Ph.D., and Sydney Young, D.Sc., F.R.S.

In the fractionation of American petroleum from which the aromatic hydrocarbons have not been removed previously by treatment with a mixture of sulphuric and nitric acids, it is noticed that the benzene comes over chiefly at about 65°, the fractions above and below this temperature containing smaller and smaller amounts of it.

The approximate estimate of the amount of benzene is easily obtained by treating the fractions repeatedly with mixed nitric and sulphuric acids and diluting the acid with water. The dinitrobenzene separates after

some time in needle shaped crystals. The most probable explanation of the lowering of the boiling point of benzene appeared to be that aromatic hydrocarbons and paraffins, though miscible in all proportions, approximate in their behaviour to partially miscible liquids. The results obtained show that this is the case, for there is always expansion on mixing, and the boiling point of normal hexane is hardly raised by the addition of even 10 per cent. of benzene, whilst that of benzene is very rapidly lowered by adding hexane.

It is therefore impossible to separate pure normal hexane by distillation of any mixture of this paraffin with benzene, though it is easy to separate pure benzene from a mixture containing only a moderate amount of hexane.

***121.** "The action of fuming nitric acid on the paraffins and other hydrocarbons." By Francis E. Francis, B.Sc., Ph.D., and Sydney Young, D.Sc., F.R.S.

In the separation of pure normal hexane from American petroleum, the methylpentamethylene was removed by heating the nearly pure hydrocarbon with fuming nitric acid during several days. It was observed at the same time that the low boiling fractions, containing isohexane, were also purified by this treatment, and that, on diluting the nitric acid, considerable quantities of a trinitro-derivative of isohexane separated as a crystalline solid.

Other isoparaffins were found to react rapidly with fuming nitric acid when heated on a water bath, and to yield liquid or solid nitro-compounds, but the normal paraffins were attacked only very slowly, and, in these cases, the acid, when diluted, did not become turbid. Details are given of the action of fuming nitric acid on isopentane, isohexane, isoheptane, iso-octane, and di-isobutyl.

The behaviour of the paraffins, when heated with fuming nitric acid, is compared with that of other classes of hydrocarbons.

DISCUSSION.

Mr. GROVES asked to what extent olefines were present in petroleum.

Mr. DAVIS referred to Worstall's statement that normal hexane yields a considerable amount of the primary nitro-derivative when boiled with fuming nitric acid during a long period (*Amer. Chem. J.*, 1898, 20, 202), and asked whether this had been observed by the authors, as such a method of purifying normal hexane would appear to be rather destructive.

Professor YOUNG, in reply, said that the olefines present in American petroleum must be inconsiderable in amount, as very little bromine is

required to produce a permanent coloration; they would, of course, be eliminated during the treatment with mixed nitric and sulphuric acids.

With respect to the action of nitric acid, it must be remembered that the result is greatly influenced by the conditions, thus Konowaloff had shown that normal hexane and normal octane yield secondary nitro-compounds on heating with dilute nitric acid under pressure. Dr. Francis and he had found that the isoparaffins undergo nitration readily when heated with fuming nitric acid in a reflux apparatus on a water bath. The normal paraffins were much more slowly attacked under similar conditions, and as the nitric acid remained clear on dilution, it was evident that nitro compounds had not been formed from them in any appreciable quantity.

***122. "A composite sodium chlorate crystal in which the twin law is not followed." By William Jackson Pope.**

The author describes a composite crystal of sodium chlorate deposited from a pure aqueous solution. It consists of a cube-shaped crystal growing on to a tabular one; both crystals show the form {100}; a three-fold axis of symmetry of the one coincides in direction with a four-fold axis of symmetry of the other, and the plane (011) on the former is parallel to the plane (010) on the latter. The composite crystal is thus not developed in accordance with the ordinary twin law, and yet the two crystalline individuals have grown together in a highly symmetrical manner.

***123. "Stereoisomeric bromonitro- and chloronitro-camphors." By T. Martin Lowry, B.Sc.**

The action of nitric acid on bromocamphor and on chlorocamphor leads to the production of only one nitrobromo- and nitrochloro-camphor. The action of bromine and of chlorine on an alkaline solution of nitrocamphor yields in each case, however, a mixture of stereoisomerides, similar to that which is produced by the action of bromine on chlorocamphor (*Trans.*, 1898, **73**, 569). The stereoisomeric bromonitro- and chloronitro-camphors, isolated from this mixture, have the following melting points and specific rotatory powers:—

	M. p.	$[\alpha]_D$ (chloroform).
α -Chloro- α' -nitrocamphor.	95°	- 5°
α' -Chloro- α -nitrocamphor	132	+ 13
α -Bromo- α' -nitrocamphor	107	- 22
α' -Bromo- α -nitrocamphor	106	+ 53

*124. "Camphoryloxime (camphonitrophenol)." By T. Martin Lowry, B.Sc.

The so-called 'camphonitrophenol,' produced by boiling nitro-camphor with concentrated hydrochloric acid, is shown to be an oxime of camphoric anhydride, identical with that obtained by the interaction of hydroxylamine with camphoric anhydride. Its constitution is probably that represented by the formula $C_8H_{14} \begin{array}{l} \diagup \\ \diagdown \end{array} \begin{array}{l} C:N \cdot OH \\ CO \cdot O \end{array}$.

125. "The formation of ethereal salts of polycarboxylic acids." By S. Ruhemann and A. V. Cunningham.

The authors have found that the condensation of ethylic malonate and its homologues with the ethylic salts of unsaturated acids, leading to the formation of those of polycarboxylic acids, is readily brought about by adding a small quantity of sodium ethoxide (0.5 gram) to the mixture of ethereal salts. In a number of cases, the combination is accompanied by an evolution of heat, the intensity of which appears to depend on the negative character of the salts entering into reaction.

The preparation of a number of salts of polycarboxylic acids by this method is described, and the conclusion is drawn that in the same measure as the negative character is diminished by the introduction of an alkyl radicle into ethylic malonate or the ethylic salt of the unsaturated acid, so does the heat evolved in the reaction decrease.

126. "Note on the action of light on platinum, gold, and silver chlorides." By E. Sonstadt

The action of direct sunlight on very dilute solutions of potassium chloroplatinate is similar to that of prolonged heating, platinum monochloride being separated, as described in an earlier paper (*Proc.*, 1898, 14, 25). The action of bright sunshine is, however, slower and feebler than that of heat. Solutions of gold chloride, if sufficiently dilute, are more readily affected by light than corresponding platinum solutions. An aqueous solution containing about 0.04 per cent. of gold chloride required exposure to bright sunshine for a day or two before any action was perceptible, and the reduction was incomplete even after exposure during several weeks. A more dilute solution, containing 0.007 per cent. of gold chloride, became distinctly bluish after a few hours' exposure, and the blue coloration deepened day by day until a deposit formed, which was blue by transmitted light, and afterwards

assumed the usual brown colour of precipitated gold, the liquid being left colourless. A trace of hydrogen peroxide was detected in the liquid. The reaction may therefore be considered to be the same in this case as when a very dilute solution of auric chloride is decomposed by heat (*Chem. News*, 1898, 77, 74).

It seemed probable that the action of light on silver chloride would, like the decomposition of platinum and gold chlorides in dilute solution by the action of heat or of light, depend on the presence of water and the formation of hydrochloric acid and hydrogen peroxide. Some silver chloride, precipitated from solution of silver nitrate by hydrochloric acid, was thoroughly washed by agitation with repeated portions of water, and decantation, the operations being conducted by feeble gas light, and then exposed under water to direct sunlight, with frequent agitation. After some days, the supernatant water was examined, and was found to contain a very appreciable quantity of hydrochloric acid, and to give a faint reaction for hydrogen peroxide. One of the two formulæ which will satisfy these conditions is $6\text{AgCl} + 4\text{H}_2\text{O} = 2\text{Ag}_2\text{Cl} + 2\text{Ag} + 2\text{H}_2\text{O}_2 + 4\text{HCl}$. But as silver, set free molecularly in presence of hydrochloric acid, would, on a reasonable presumption, form silver chloride with liberation of hydrogen, and as the nascent hydrogen would react on part of the hydrogen peroxide to form water, the equation, with these corrections, becomes $6\text{AgCl} + 4\text{H}_2\text{O} = 2\text{Ag}_2\text{Cl} + 2\text{AgCl} + 2\text{HCl} + 2\text{H}_2\text{O} + \text{H}_2\text{O}_2$. The same series of reactions would occur with the re-formed silver chloride and water, and it is obvious that, as, at each stage of the reaction, one-third of the silver chloride and one-half of the water are reproduced, and similarly with the hydrochloric acid and hydrogen peroxide, it follows that when the silver chloride taking part in the reaction is completely converted into argentous chloride, water will still be left as a permanent residue in addition to hydrochloric acid and hydrogen peroxide. This assumes that the silver chloride in a condition of accessibility to the influence of light is in the exact proportion to the water present indicated in the equation. But if the attackable silver chloride is present in a certain excess over that required by the equation, the end products of the series of reactions may be represented by the simple equation, $4\text{AgCl} + 2\text{H}_2\text{O} = 2\text{Ag}_2\text{Cl} + 2\text{HCl} + \text{H}_2\text{O}_2$, in which no residue of water appears. This is the second of the two possible formulæ referred to, and, it may be asked, what need is there to assume the complex reactions in series following from the first formula, when the second, which is so much simpler, satisfies the experimental results? There are, however, other experimental results of a singular character to be described, which may possibly be considered to be more easily intelligible on the supposition that the reactions are of the serial nature involved in the first equation.

Some silver chloride, precipitated and washed as already described, was dried for several hours on a sand bath, the temperature being raised progressively until the chloride became adhesive. Although the process was conducted under very feeble gas light, the chloride was sensibly discoloured. This discoloration is probably due to the same reaction taking place between moisture and the chloride under the influence of a high temperature as is effected by light in the cold. It appears that a higher temperature is needed for the reaction than that of water boiling at ordinary pressure, as the chloride is not discoloured by heating under water. A thoroughly dry and heated glass tube was nearly filled with the hot chloride, and immediately sealed. Another portion of the chloride was put into a bulb tube which had been previously dried and strongly heated, and was fused in the bulb. A slight, but unmistakable, trace of moisture condensed on the sides of the tube, showing that the chloride was not perfectly dry. The tube containing the (imperfectly) dried silver chloride was exposed to direct sunshine, when a bluish tint instantly spread over the chloride, deepening to a rusty brown, but leaving patches unaffected, so that, after long exposure, the fragments presented a mottled appearance with white spots on a dark ground. Evidently, portions of the chloride were really dry, though the bulk was not so, the dry portions resisting the action of light. Another tube, rather long and narrow, was similarly filled with the dried chloride, sealed, and exposed to sunshine with about half its length covered. The exposed portion of the chloride darkened as in the former case, with patches remaining unaffected. The covering was then shifted over the previously exposed part of the tube, with a like result; but the darkened chloride, now sheltered from light, became slowly bleached, until it was quite white. On again reversing the conditions, the bleached portion darkened, and the coloured portion was bleached, the same happening on each subsequent reversal. Even in the portion of the tube exposed to bright sunshine, the chloride on the under side became partially bleached, and on turning the tube round, the effect, after a few hours, was reversed. Dry silver chloride was then placed in the central part of a phial tube, and was protected by a little recently ignited asbestos from contact with fragments (placed in its lower and upper parts) of calcium chloride, and of caustic soda taken from sodium that had been long kept in a loosely closed bottle. The well-closed phial was kept in the dark during two or three days, to give time for absorption of moisture, and was then exposed to sunshine. The silver chloride became coloured, with white spots remaining unattacked, as in the former cases; but, on transference to a dark place, or on shading a portion, there was no bleaching. The coloration

remained practically constant in light and in shade. The bleaching effect, or the re-formation of argentic from argentous chloride under the conditions described in the former case, must therefore be attributed to a reversal in the dark of the primary reaction which takes place in the light; a reversal made impossible in the last-mentioned case by the absorptive action of the calcium chloride and the soda. Hydrochloric acid has no bleaching effect on light-altered silver chloride suspended in water, either in darkness or in light.

127. "Methanetrisulphonic acid." By Ernest H. Bagnall, B.Sc.

In endeavouring to prepare the various sulphonic acids and sulphones of dichlorobenzidine by the action of fuming sulphuric acid on dichlorodiacylbenzidine, a substance was obtained which proved to be identical with methanetrisulphonic acid (Theilkuhl, *Annalen*, 1868, 147, 134). This acid is also formed by a like process from diacylbenzidine, acet- α -naphthalide, and acetanilide, the last giving a remarkably good yield of the substance. The silver salt crystallised in small, white, iridescent, monhydrated, orthorhombic plates, $a : b : c = 2.9152 : 1 : 0.5422$. The copper, barium, calcium, potassium, sodium, and ammonium salts are also described.

Attempts were made to prepare the corresponding sulphonic acids of ethane and propane by a similar process, but without satisfactory results.

128. "The nutrition of yeast." By Arthur L. Stern, D.Sc.

This investigation was undertaken to determine the amount of inorganic and nitrogenous nutriment required to produce the largest crop of yeast, the greatest assimilation of nitrogen, and the most complete fermentation in a fixed time. During the course of the investigation, other points had to be considered, of which the most important was the part played by sulphur compounds on yeast nutrition. The earlier work of Hayduck, who employed a different variety of yeast and a different variety of sugar, is referred to (*Zeitschr. für Spiritusind.*, 1881, 173).

The yeast employed was a pure form obtained from a Burton pitching yeast, the sugar was *d*-glucose, the nitrogenous nutriment asparagine, and the inorganic nutriment of two kinds: the first prepared from a yeast ash and free from sulphur, the second a mixture of potassium phosphate, magnesium sulphate, and calcium sulphate. Each experiment consisted in fermenting 500 c.c. of a 10 per cent. solution of the sugar, to which varying amounts of the nitrogenous and inorganic nutriment had been added.

It is shown that sulphur is an essential constituent of yeast nutriment, and that in the absence of other more suitable forms of sulphur nutriment, sulphates can supply the yeast with this element, a portion of the sulphate being invariably reduced to sulphuretted hydrogen. Attempts were made to find a substance of known constitution which could supply yeast with sulphur without the evolution of sulphuretted hydrogen, but without success.

It has been asserted that iron is an essential constituent of yeast nutriment. but no evidence could be obtained in support of this statement.

The author has examined the effect of variation in the amount of (1) nitrogen nutriment and (2) inorganic nutriment respectively on the amount of nitrogen assimilated, the percentage of nitrogen nutriment assimilated, the percentage of nitrogen contained in the yeast, the percentage of sugar remaining unfermented, and the weight of the yeast crop, and draws the following conclusion:—Any increase of nutriment beyond a definite limit will not materially increase the amount of nitrogen assimilated by the yeast, the percentage of nitrogen in the yeast, the weight of the yeast, or the amount of sugar fermented. This limit, called the normal supply, is the largest quantity that the yeast can assimilate under the conditions employed in the experiments, and is approximately 0.025 gram of inorganic nutriment per 100 c.c., and the same weight of nitrogen supplied as asparagine.

129. "The yellow colouring matters of *Rhus Cotinus* and *Rhus rhodanthema*. Part VI." By Arthur George Perkin.

Venetian sumach, the leaves of *R. Cotinus*, contains myricetin and not quercetin as stated by Löwe (*Zeit. anal. chem.*, 1874, 12, 127). The leaves of *R. rhodanthema*, the yellow cedar of New South Wales, contain quercetin and gallotannic acid. The stems of both plants contain fisetin, and the leaves thus contain the more highly oxidised colouring matters, as quercetin and myricetin are considered to be hydroxy- and dihydroxy-fisetin respectively. Other members of the *Rhus* family hitherto examined contain no fisetin in the stem. The Venetian sumach examined contained 16.7 per cent. and the *R. rhodanthema* leaves 9.5 per cent. of tannin.

The leaves of *Artocarpus integrifolia* (Jackwood tree), *A. incisa* (bread fruit), and *A. lakoocha* are devoid of colouring matter.

130. "Colouring matters of the New Zealand dyewood 'puriri.'" By Arthur George Perkin.

"Puriri" (*Vitex littoralis*) is a large tree, growing in northern New Zealand, and chiefly used for building and similar purposes. Its

tinctorial properties are little known. It contains two colouring matters in the form of glucosides.

Vitexin, $C_{15}H_{14}O_7$ or $C_{17}H_{16}O_8$, the chief product, is a canary-yellow crystalline powder, distinguished by its sparing solubility in most solvents. Owing to the difficulty of obtaining substitution products without decomposition, its molecular weight is at present uncertain. *Acetyl-vitexin*, $C_{15}H_9O_7Ac_5$ or $C_{17}H_{10}O_8Ac_6$, forms colourless needles melting at $251-256^\circ$. On fusion with alkali, phloroglucinol, acetic and parahydroxybenzoic acids are formed, whilst boiling aqueous or alcoholic potash solutions give phloroglucinol and parahydroxyacetophenone. Further, the product of the ethylation of vitexin with boiling alcoholic potash yields paraethoxybenzaldehyde, paraethoxybenzoic acid, and a phloroglucinol derivative. Warm nitric acid (sp. gr. 1.54) forms metadinitroparahydroxybenzoic and picric acids, but when dilute acid is employed, a sparingly soluble *nitro*-compound, $C_{15}H_6O_5(NO_2)_4$, of unknown constitution, is also obtained in small quantity. This consists of small lemon-yellow needles, which dye mordanted calico; it is converted by strong nitric acid into picric acid, and appears to be closely related to vitexin. With nitrobenzene, it forms an addition product, $C_{15}H_6O_5(NO_2)_4.C_6H_5NO_2$, crystallising in orange-coloured needles which lose nitrobenzene at 150° , or by digestion with alcohol. Vitexin gives very pure yellow shades on calico mordanted with chromium and aluminium salts, but owing to its insolubility these are of a poor character. They somewhat resemble the corresponding shades given by apigenin, and as the chief decomposition products of both colouring matters are identical, it is probable that apigenin and vitexin are closely related.

Homovitexin, $C_{16}H_{16}O_7$ or $C_{18}H_{18}O_8$, is present in the wood only in minute quantity. It crystallises in fine primrose-yellow needles, melts at $245-246^\circ$, and is distinguished from vitexin, which it otherwise resembles, by its ready solubility in alcohol. Fusion with alkali gives phloroglucinol and parahydroxybenzoic acid, and treatment with dilute nitric acid yields metadinitroparahydroxybenzoic acid. It dyes mordanted fabrics feebly.

The shades given by "puriri" with chromium and aluminium mordants are distinguished by their pure yellow tone, and may have some commercial utility.

131. "Cannabinol." By T. B. Wood, M.A., W. T. N. Spivey, M.A., and T. H. Easterfield, M.A., Ph.D.

In former communications (*Proc.*, 1898, 14, 66, 153) a number of derivatives of cannabinol have been described; a detailed account of these is given in the present paper. The oily lactone (*loc. cit.*, 153),

prepared from nitrocannabinolactone (oxycannabin), is shown to be a metatolylbutyrolactone, oxycannabin being the corresponding nitro-derivative. By the oxidation of cannabinolactone, a lactonic acid is produced, which on fusion with potash yields isophthalic acid.

Nitrocannabinolactonic acid is obtained by oxidising oxycannabin either by dilute nitric acid in a sealed tube, or by potassium permanganate.

The volatile fatty acids produced on oxidising cannabinol by nitric acid are shown to be normal butyric (Dunstan and Henry, *Proc.*, 1898, 14, 44), normal valeric, and normal caproic acids, valeric acid being formed in the largest amount.

132. "Derivatives of hesperitin." By A. G. Perkin.

Hesperitin is found as the glucoside hesperidin in the citron, bitter orange, and other fruits of the same class. With potassium hydrate solution at 100° , it gives phloroglucinol and hesperitinic or hydroxymethoxycinnamic acid. It thus appears to have the constitution $\text{OH}\cdot\text{C}_6\text{H}_3(\text{OMe})\cdot\text{CH}:\text{CH}\cdot\text{CO}\cdot\text{O}\cdot\text{C}_6\text{H}_3(\text{OH})_2$ (Hoffmann, *Ber.*, 1876, 9, 685; Tiemann and Will, *Ber.*, 1881, 14, 948). With alcoholic potassium and sodium acetates, hesperitin gives the compounds $(\text{C}_{16}\text{H}_{14}\text{O}_6)_2\cdot\text{KC}_2\text{H}_3\text{O}_2$, and $(\text{C}_{16}\text{H}_{14}\text{O}_6)_2\cdot\text{NaC}_2\text{H}_3\text{O}_2$, which form colourless needles and decompose on treatment with boiling water, regenerating hesperitin. With sodium and potassium bicarbonates, *sodium hesperitin*, $\text{C}_{32}\text{H}_{27}\text{O}_{12}\text{Na}$, and *potassium hesperitin*, $\text{C}_{32}\text{H}_{27}\text{O}_{12}\text{K}$, are obtained, crystallising in minute, colourless plates. The formula of hesperitin is thus $\text{C}_{32}\text{H}_{28}\text{O}_{12}$.

Azobenzenehesperitin, $\text{C}_{32}\text{H}_{24}\text{O}_{12}(\text{N}_2\text{Ph})_4$, forms red needles, melts at $246\text{--}247^{\circ}$, and yields a *diacetyl* derivative, $\text{C}_{32}\text{H}_{22}\text{O}_{12}\text{Ac}_2(\text{N}_2\text{Ph})_4$, crystallising in ochre needles melting at $240\text{--}242^{\circ}$. Hesperitin should thus contain six hydroxyl groups, and this view of its constitution is confirmed by the formation of *acetylhesperitin*, $\text{C}_{32}\text{H}_{22}\text{O}_6\text{Ac}_6$, which crystallises in colourless needles melting at $127\text{--}129^{\circ}$.

If hesperitin were $\text{C}_{16}\text{H}_{14}\text{O}_6$, the constitution assigned by Tiemann and Will would thus be correct. Though not considered to be a polymeride of a substance of this formula, it must consist of two very similar groups linked together, as Hoffmann (*loc. cit.*) obtained from hesperitin a nearly quantitative yield of phloroglucinol and hesperitinic acid.

ADDITIONS TO THE LIBRARY.

I. *Donations.*

Allen, A. H. Commercial Organic Analysis. 2nd Edition. Vol. IV. Proteids and Albuminous Principles, Proteoids or Albuminoids. Pp. ix + 579. London 1898. From the Author.

Attfield, John. Chemistry: General, Medical, and Pharmaceutical; including the Chemistry of the British Pharmacopœia. 17th Edition. Pp. xxii + 885. With 1 Plate and 4 Folding Sheets. London 1898. From the Author.

Beddow, F. First Stage. Inorganic Chemistry (Practical). Pp. viii + 165. London 1898. From the Author.

Briant, Lawrence. Laboratory Text-Book for Brewers. 2nd Edition. Pp. 356. With 5 unpagéd Plates. London 1898. From the Author.

Briggs, W., and Stewart, R. W. Chemical Analysis, Qualitative and Quantitative. Pp. viii + 128. London 1898. From the Authors.

Dibdin, W. J. The Purification of Sewage and Water. 2nd Edition. Pp. xvi + 276. With 15 folding and unpagéd Plates. London 1898. From the Author.

George, George. Practical Organic Chemistry. Pp. 96. London 1898. From the Author.

Jones, Chapman. An Introduction to the Science and Practice of Qualitative Chemical Analysis. (Inorganic.) Pp. viii + 213. London 1898. From the Author.

Landauer, John (trans. Tingle, J. B.). Spectrum Analysis. With 44 Figs. in the Text. Translated by J. Bishop Tingle. Pp. x + 239. New York 1898. From the Translator.

von Meyer, E. (trans. McGowan, G.). A History of Chemistry from Earliest Times to the Present Day. 2nd Edition. Translated by George McGowan. Pp. xxiii + 931. London 1898. From the Translator.

Patent Office Library, Catalogue of. Arranged Alphabetically. Vol. I. Authors. Pp. 1007. London 1898. From the Controller.

Pharmaceutical Formulas: A Book of Useful Recipes for the Drug Trade, collated chiefly from *The Chemist and Druggist* and *The Chemists' and Druggists' Diaries*. By Peter MacEwan. Pp. v + 664. London 1898. From the Author.

II. *By Purchase.*

von Georgievics, G. Lehrbuch der chemischen Technologie der Gespinnstfasern. II. Theil. Pp. ix + 354. With 47 Figs. in the Text. Leipzig 1898.

Storer, F. H. Agriculture in some of its Re[gu]lations with Chemistry. 7th Edition. 3 vols. Vol. I, pp. iv + 620 ; Vol. II, pp. iv + 602 ; Vol. III, pp. vi + 679. London 1898.

BANQUET TO PAST PRESIDENTS.

Fellows who have announced their intention to be present at the Banquet to Past Presidents at the Hôtel Métropole on Friday, November 11th, are informed that dinner will be served *punctually* at 7 o'clock.

RESEARCH FUND.

A meeting of the Research Fund Committee will be held in December. Applications for grants, accompanied by full particulars, should be received by the Secretaries not later than December 5th. Forms of application can be obtained from the Assistant-Secretary, Chemical Society, Burlington House, W.

NOTICE TO AUTHORS.

As the *Proceedings* go to press on the Monday after each ordinary Meeting of the Society, the announcement of papers for the next Meeting cannot be made in this publication unless the papers are in the hands of the Secretaries by noon on that day.

At the next meeting, on November 17th, the following papers will be communicated :—

“Preparation of hyponitrite from nitrite through oxyamidodisulphonate.” By E. Divers, M.D., F.R.S., and T. Haga, B.Sc.

“Absorption of nitric oxide in gas analysis.” By E. Divers, M.D., F.R.S.

“Interaction of nitric oxide with silver nitrate.” By E. Divers, M.D., F.R.S.

“Preparation of pure alkali nitrites.” By E. Divers, M.D., F.R.S.

“The reduction of an alkali nitrite by an alkali metal.” By E. Divers, M.D., F.R.S.

“Hyponitrites: their preparation by sodium or potassium and properties.” By E. Divers, M.D., F.R.S.

PROCEEDINGS

OF THE

CHEMICAL SOCIETY.

EDITED BY THE SECRETARIES.

No. 199.

Session 1898-9.

THE BANQUET TO PAST PRESIDENTS.

The Banquet to the Past Presidents who have been Fellows for half a century :—

	Elected.	President.
Gilbert, Sir Joseph Henry, F.R.S. .	May 18, 1841 . .	1882-83.
Frankland, Sir Edward, K.C.B., F.R.S.	December 20, 1847 . .	1871-73.
Odling, William, M.B., F.R.S. . .	January 17, 1848 . .	1873-75.
Abel, Sir Frederick Augustus, Bart., K.C.B., F.R.S. . . .	March 21, 1848 . .	1875-77.
Williamson, Alexander William, LL.D., F.R.S.	May 15, 1848 . .	{ 1863-65. 1869-71.
Gladstone, John Hall, Ph.D., F.R.S.	December 18, 1848 . .	1877-79.

was held at the Whitehall Rooms, Hôtel Métropole, on Friday, November 11th, 1898, Professor James Dewar, F.R.S., President, in the Chair.

The following Fellows and guests were present :—

Abel, Sir F. A., Bart., K.C.B., F.R.S.	Basset, Mr. Henry.
Aikin, Dr. W. Arthur.	Beadle, Mr. Clayton.
Allchin, Dr. W. H.	Beale, Mr. W. P., Q.C.
Allen, Mr. A. H.	Beilby, Mr. George, <i>President, Society of</i> <i>Chemical Industry.</i>
Armstrong, Prof. H. E., F.R.S.	Bell, Mr. Chichester A.
Atkinson, Dr. E.	Birdwood, Sir George, M.D., K.C.S.I.
Attfield, Prof. John, F.R.S.	Blagden, Mr. W. G.
Bailey, Mr. Henry.	Blount, Mr. Bertram.
Baker, Mr. H. B.	Bloxam, Mr. A. G.
Barlet, Mr. S.	Borns, Dr. Henry.
Barnes, Mr. G. C.	Böttinger, Dr. H. T.
Barry, Sir J. Wolfe, K.C.B., F.R.S., <i>Chairman of Council, Society of Arts.</i>	Bowley, Mr. J. J.

- Brierley, Mr. J. F.
 Brothers, Mr. Alfred.
 Brothers, Mr. H. E.
 Brough, Mr. B. H.
 Brown, Prof. F. D.
 Brown, Dr. H. T., F.R.S.
 Brown, Prof. J. Campbell.
 Brown, Mr. N. T.
 Browne, Sir J. Crichton, F.R.S.
 Brunton, Dr. T. Lauder, F.R.S.
 Butt, Mr. E. N.
 Burge, Mr. C. H.
 Burgess, Mr. W. T.
 Burne, Major-Gen. Sir Owen Tudor,
 G.C.S.I.
 Calvert, Mr. J. H.
 Cambridge University, Vice-Chancellor
 of.
 Carpmal, Mr. A.
 Carteighe, Mr. M.
 Chattaway, Dr. F. D.
 Clarke, Sir Ernest, *Secretary, Royal*
 Agricultural Society.
 Clerk, Mr. Dugald.
 Clowes, Prof. F.
 Cookson, Mr. C.
 Cooper, Mr. Albert.
 Cooper, Mr. A. J. Bullen.
 Cooper, Mr. H. Creemer.
 Corfield, Prof. W. H.
 Cousins, Mr. W. J.
 Cresswell, Mr. C. G.
 Crookes, Mr. Joseph.
 Crookes, Sir William, F.R.S.
 Crossley, Dr. A. W.
 Dewar, Prof. James, F.R.S., *The Presi-*
 dent.
 Diamond, Mr. H. E.
 Dibdin, Mr. W. J.
 Dickens, Mr. F. Victor, *Registrar of the*
 University of London.
 Dodd, Mr. T. H.
 Donnelly, Maj.-Gen. Sir John, K.C.B.
 Secretary, Science and Art Depart-
 ment.
 Duggan, Mr. T. R.
 Dunstan, Prof. Wyndham, F.R.S., *Hono-*
 rary Secretary.
 Dupré, Dr. A., F.R.S.
 Dyer, Dr. Bernard, *President, Society of*
 Public Analysts.
 Dymond, Mr. T. S.
 Elder, Mr. H. M., *Secretary, Physical*
 Society.
 Elliott, Mr. T. H., C.B., *Secretary,*
 Board of Agriculture.
 Evans, Sir John, K.C.B., Treas. R.S.
 Evershed, Mr. Frank.
 Fairley, Mr. Thomas.
 Fenton, Mr. H. J. H.
 Festing, Maj.-Gen. E. R., F.R.S., *Dirce-*
 tor, Science Museum, S. Kensington.
 Fisher, Mr. E. H.
 Fisher, Mr. W. W.
 Formoy, Mr. J. A.
 Forster, Dr. M. O.
 Foster, Prof. G. C., F.R.S.
 Foster, Prof. Michael, Sec. R.S., *Presi-*
 dent-Elect, British Association.
 Francis, Mr. G. B.
 Frankland, Sir Edward, K.C.B., F.R.S.
 Frankland, Prof. P. F., F.R.S.
 Friswell, Mr. R. J.
 Gardner, Mr. J. A.
 Garwood, Mr. E. J.
 Geikie, Sir Archibald, F.R.S.
 Gilbert, Sir J. H., F.R.S.
 Gilchrist, Mr. D. A.
 Gladstone, Dr. J. H., F.R.S.
 Goldsmith, Mr. J. N.
 Goodwin, Mr. H. B., R.N.
 Gowland, Mr. William.
 Greenaway, Mr. A. J., *Sub-Editor.*
 Griffith, Mr. George.
 Grossman, Mr. E. H.
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 maeuctical Society.
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 MacArthur, Mr. J. S.
 Mac Ewan, Mr. Peter.

- MacMahon, Major P. A., R.A., F.R.S.
 Macnab, Mr. W.
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 Mallet, Mr. F. R.
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 McAlpin, Mr. K. W.
 McLeod, Prof. Herbert, F.R.S.
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 Milner, Mr. J. W.
 Minchin, Prof. G. M., F.R.S.
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 Ramsay, Prof. William, F.R.S.
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 Spiller, Mr. William.
 Sprengel, Prof. H., F.R.S.
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 Stevenson, Dr. Thomas, *President, Institute of Chemistry*.
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 Wade, Mr. J. L.
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 Williamson, Mr. O. K.
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 Wood, Sir H. Trueman, *Secretary, Society of Arts*.
 Woodward, Dr. Henry, F.R.S.
 Wright, Mr. F. H.
 Wynne, Dr. W. P., F.R.S., *Honorary Secretary*.

The following toasts were proposed :—

“HER MOST GRACIOUS MAJESTY THE QUEEN.”

THE PRESIDENT: “My Lords, Venerated Presidents, and Gentlemen, —I have now the honour to propose to you the first toast. We are aware that the advancement of learning necessitates the possession of a peaceful environment, and that good sovereignty generates it. During the long life of Her Most Gracious Majesty the Queen, Science has developed by extraordinary leaps and bounds. But for the peaceful quiet the scientific man has enjoyed, that progress would have been impossible. Every scientific man therefore may acclaim with the poet ‘She wrought her subjects lasting good.’ Long may she rule over this great empire, beloved and revered of her people. I give you ‘The Health of Her Most Gracious Majesty the Queen.’

“T.R.H. THE PRINCE AND PRINCESS OF WALES.”

THE PRESIDENT: “I have now the honour of proposing to you the second toast, the health of ‘Their Royal Highnesses the Prince and Princess of Wales and the other Members of the Royal Family.’ We know that His Royal Highness possesses in quite an exceptional degree two princely attributes, wisdom and prudence. We, as a nation, have recently had the opportunity of observing during the long time of trial that His Royal Highness has passed through, that he possesses another virtue, that of fortitude. I am sure that we shall all look forward with pleasure to his rapid recovery, and to his return to the discharge of those multifarious duties he performs so well. I am sure that the whole sympathy of the nation is extended to Her Royal Highness the Princess of Wales in the severe calamity that has befallen Her Royal House. I ought to mention that when this banquet was first proposed, a letter was sent from Marlborough House that expressed His Royal Highness’s views with regard to the action of the Society. He said he would like to have honoured the distinguished chemists, especially Lord Playfair, ‘one of my earliest friends,’ by being present, had his engagements permitted it. Alas! since that time Lord Playfair has passed away full of honours and renown. The Society has thus lost its oldest President and its one remaining original member. I give you the health of ‘The Prince and Princess of Wales and the other Members of the Royal Family.’”

“THE PAST PRESIDENTS.”

THE PRESIDENT: “I have now the honour to propose to you what you must all regard as a toast to which I cannot possibly do justice, the health of six of the most distinguished Past-Presidents of

the Chemical Society who for more than half a century have been members of that body. It is admitted on all hands that Chemical Science has added enormously to the resources and power of mankind, and that its successful cultivation involves the exercise of every faculty of the human mind. We have here six illustrious examples of successful scientific culture, and, I would add, of bracing moral influence; men whose one idea it has been, with steady aim and vigilant eye, to labour on with that sole incentive of scientific work, the triumphant hope of making an advance. These men have laboured for half a century in our interests, and they have added enormously to our knowledge of the science. It is almost impossible to realise the variety of the work they have done; the width of it is something appalling; when I tell you that, amongst them, they have recorded upwards of four hundred and fifty separate communications—how many there are that have not been recorded, I cannot say—and that among these four hundred and fifty there are many papers of the highest importance, I am sure you will agree with me that they have exercised a remarkable influence on the development of our science. It was well that the Chemical Society of London—the oldest Chemical Society in the world—should inaugurate this banquet. The Council felt that probably they might never again have the opportunity of calling together such a distinguished body of men as they have the honour of offering this banquet to to-night. We are still able to go back to a man, who sits on my right hand, who worked in the laboratory of Thomas Thomson, who has seen Dalton and the beginning of the Atomic Theory, probably the most wonderful of all the laws of Nature which man has ever been permitted to decipher. That being the case, the way in which the idea has been received by all the chemists of this country is apparent from the number of men of talent and the variety of classes here to-night. But beyond that, the sympathy of every chemist in the world is with us to-night at this banquet. The large number of congratulatory telegrams and communications that we have received to-day from every country where the science of chemistry is cultivated, will give some idea of the appreciation with which this banquet is regarded throughout the whole civilised world. We have received communications from France, Holland, Belgium, Germany, Sweden, Russia, Austria, the United States, and other countries. It is unnecessary for me to read every name, for every man identified with the progress of chemistry in every civilised country has responded by sending some form of congratulation. In every case they write as if they were present with us, as you will understand from the few illustrations I will give you of the sympathetic language they use. Professor Friedel writes: ‘I should have been happy to associate myself with the Chemical Society in doing honour to these veterans of science. I have the honour to be the friend

of most of them, and the beneficent action they have exerted on Chemical Science cannot be esteemed too highly. They form the finest phalanx of the Fathers of our science which exists in any country. With these sentiments, you will understand the liveliness of my regret to be able to take part from afar and in spirit only in the honour paid them.' We have also received congratulations from learned societies both in Germany and Russia. At a meeting of the Russian Chemical Society the following resolution was passed: 'That the Society avail itself of the exceptional opportunity of being able to congratulate conjointly Sir Joseph Henry Gilbert, Sir Edward Frankland, Professor Odling, Sir F. A. Abel, Dr. A. W. Williamson, and Dr. J. H. Gladstone, whose distinguished services during half a century stand out as a model for all investigators in chemical science, and also express the wish to see the further results of their labours in the annals of science for many years to come.' The telegram from the German Chemical Society strikes me as very happy. Dr. Liebermann says: 'The sister Society sends both Jubilee congratulations and greetings to the Jubilee celebration of the Presidents of the Chemical Society, Gilbert, Frankland, Odling, Abel, Williamson, and Gladstone.' This shows, I think, that our Continental brethren appreciate the honour we desire to offer these distinguished men; and we need not be surprised that there is something more throughout these communications than mere cosmopolitanism in science. They breathe the spirit of friendly regard, of reverence, and even of love towards men who have done so much to advance the common cause of our science. How impossible it seems to sum up in any short speech the work that these men have done! If I attempted to classify them, I should say, that if we regarded them as twos and twos they would not group well together, but if we take three at a time, they bear somewhat close relations one towards another. I would say that Gilbert and Abel and Gladstone are monarchs of dependent kingdoms, whereas Frankland and Odling and Williamson are a triumvirate that have legislated towards the imperial side of chemical science.

"The work of Gilbert, as we know, was early differentiated into that most complex and mysterious study, the study of organic life. For the last fifty years he has devoted his attention to the physiology of plant life in every phase of its development. With a skill that has been unprecedented, he has recorded from year to year the variations in the growth of every kind of nutritious plant. He has examined into the meteorological conditions, the variations of climate, of soil and of mineral agents, of drainage, and of every conceivable thing affecting the production and development of plant growth. These memoirs are admitted throughout the world to be unique in their importance. Wherever the chemist or the physiologist, the statistician or the

economist has to deal with these problems he must turn to the results of the Rothamsted experiments in order to understand the position of the science of our time. These results will be for ever memorable: they are unique and characteristic of the indomitable perseverance and energy of our venerated President, Sir Henry Gilbert.

"The next among them, Sir Edward Frankland, I should characterise as one of the most remarkable experimentalists of this or any other age. He has been gifted with an absolutely unique faculty for experimental work and observation. The breadth and variety of his work is positively astounding. From early times devoted to the study of Organic Chemistry, he has branched out not only into Mineral Chemistry, but every form almost of applied industry. His early work on the organo-metallic bodies, so fertile in the way of future development, will be ever memorable. These bodies have been the means of adding to our knowledge of synthetical substances produced in the laboratory in a way that no other agencies have operated. Along with this work, he has executed investigations bearing on flame and the character of the light emitted by various bodies, and on a large number of questions connected with sanitary chemistry. His great work on the water supply of the United Kingdom, on the sewage question, and other industrial problems are generally acknowledged to be of great value and importance. Whatever work he has done is marked with the stamp of genius.

"The work of Odling has been an essential factor in the development of modern chemistry. It is characterised by precise and clear ideas, and an almost forensic ability for putting things in a straight, concise, and unembarrassing manner. His early labours in advancing the development of the newer chemistry deserve our warm gratitude, and his many published works and addresses on organic and inorganic chemistry, together with his translation of the work of Laurent, have all been of material service in diffusing a knowledge of our science. The papers he has contributed on Chemical Notation and on the question of types all display a marvellous precision as well as elegance of thought. Every one must admit the debt of gratitude we owe him for his iconoclastic labours in clearing out old and vague notions, and for the courageous manner in which he supported the newer ideas of his time.

"In the case of Abel, we have again a man who, at an early time, had his career differentiated for him. A distinguished student of Hofmann's, his early work was directed to organic chemistry, but he soon diverged into other channels, directing his attention to problems bearing on the chemistry of naval and military matters. We all know his splendid work on gunpowder, guncotton, detonation, and the whole field of explosive agents. Whether in connection with accidents

in mines, from petroleum, or from flour, dust or other agency, Abel has been a marvellous experimenter in the whole field of explosive chemistry. While engaged in these investigations in applied chemistry, however, he was adding to the advancement of pure science by the light which his researches threw upon many questions of chemical theory and by the stimulus thus given to further inquiry. He has had the great satisfaction of living through the age of gunpowder. That body had been the recognised explosive for many hundred years, and I have no doubt that when he commenced his investigations with Noble on gunpowder he never dreamt that he would live to see the day when he would clear out that smoky material and replace it before he left the War Office by a powder that is smokeless. I need hardly tell you that he has also added to our debt of gratitude by the personal services he has rendered to many learned societies.

"I come now to Williamson. The work of Williamson proclaims him a truly philosophic chemist. He has had probably the greatest satisfaction of any one I know. He cleared up one of the most intricate and recondite of chemical reactions, that with which we are familiar as etherification, and in so doing he struck at the very root of the chemical problems connected with atomic and molecular weights, and realised and cleared up for ever those mysterious modes of explanation which were undoubtedly faulty and insecure. Before his time, men as great as Berzelius, Mitscherlich, and Graham believed in that contact or catalytic action which in my early days bridged over the period between the old and the new, and was generally introduced when no other explanation was forthcoming. Williamson cleared all that away; but the discovery of these ethereal nepenthes did not act in chemistry as they would have done physiologically: they did not produce a soporific effect. They struck at the foundations of our science; and it is to his great credit that he originated advanced ideas, not only as to etherification, but as to molecular weights, type formulæ, and so forth. In fact the chemistry of our time would not be the chemistry of our time but for the work of Williamson. I would further add that he was one of the earliest to introduce the idea of dynamics into chemical science. His suggestion of the dynamical theory of the voltaic battery and of dynamic mobility in apparent stability has been exceedingly fruitful since his time; and if we add to them that most important and original idea of Frankland's, the saturation power of the elementary bodies, we have all the agencies of our modern scientific notions. One other debt of gratitude we owe to Williamson, and that is the interest he took in introducing into this country abstracts of all the important scientific memoirs published on the Continent. It is to him we owe those valuable abstracts which

have been printed for many years in the *Chemical Society's Journal*, and have done so much for the advancement of our science.

"Gladstone, on the other hand, represents a type somewhat different from that of any of the others that I have mentioned. He belongs to a characteristically English variety of men who have studied science for its own sake. Like Spottiswoode, De la Rue, and Joule, he has not been a professional scientist in the ordinary sense, but has worked out his long and brilliant scientific career as a labour of patient love. Furthermore, he has created an entirely new department—that which is in modern times regarded as physical chemistry, of which we have here to-night some distinguished representatives. For half a century he has worked on this side of chemistry, for his early investigation of the spectrum of the atmosphere was one of marvelous suggestiveness. He found that the spectrum of Fraunhofer varied at sunset and at sunrise from that at mid-day, and showed that a large number of those absorption lines must originate in the earth's atmosphere. That discovery stimulated further inquiry as to the substance that could produce these lines so characteristic of the solar atmosphere; and later experimenters have found it in the vapour of water and in oxygen. Gladstone's greatest merit, however, lies undoubtedly in his optical researches on the atomic refractions and dispersions of the elements. He has determined the optical constants of hundreds of bodies, and has thus stimulated inquiry in that borderland between physics and chemistry which is so much cultivated in the present day, and the pursuit of which has added so much to our knowledge. He has also contributed largely to miscellaneous inquiries, especially those connected with various voltaic batteries, and other questions conducive to the study of both organic and inorganic chemistry.

"This is but a brief epitome of the work of these great men. It would be, as I have said, hopeless for me to attempt to sum up all their individual labours. We can only skim the surface of the ocean of truth in which they have navigated so well and so successfully. But I will say this: that as experimentalists we are not likely to see their like again, and it is impossible to imagine a more extraordinary galaxy of chemical talent than these six Past-Presidents represent. They have rendered the science of chemistry more glorious for those who strive to follow; and the brilliant record of their discoveries can never be eliminated from the history of our Science. In the future, posterity will regard them as the most gifted and illustrious of the English chemists of the Victorian epoch. My Lords and Gentlemen,—I give you the health of our venerated Past-Presidents, Sir Henry Gilbert, Sir Edward Frankland, Professor Odling, Sir Frederick Abel, Professor Williamson, and Dr. Gladstone."

SIR J. HENRY GILBERT: "After the extremely flattering and eloquent

terms in which our President has referred to the work of the six Past-Presidents of the Society who are so highly honoured to-night, it is surely a difficult task to say anything in response. I feel that any words of mine would be entirely inadequate; and I must, I think, fall back on what I was intending to say, and give a little personal history of the early times of the Society. You are aware, most of you, that I am to-night in the position of the senior of the Past-Presidents, in consequence of the death of Lord Playfair. He was, as you know, one of the founders of the Society, and, before he died, the only survivor of those founders. I myself came in within three months of the foundation, and so had some knowledge of the Society's early doings. In fact, before I was really admitted to the Society, under the influence of the late Professor Graham, I undertook the translation of a paper by Redtenbacher and Liebig on 'The Atomic Weight of Carbon'; and that paper occupies eighteen pages in the first volume of the Society's *Memoirs*. I should say that, less than a fortnight ago, I received a letter from Lady Playfair, just before she left to visit her friends in America, in which she said with what interest he had looked forward to being present at the banquet appointed for June—but that was not to be. I first made the acquaintance of Playfair in Liebig's Laboratory at Giessen, the year before the establishment of this Society, that is, in 1840. Playfair was at that time very busily occupied in translating the memorable work of Liebig, *Organic Chemistry in its Applications to Agriculture and Physiology*; and before the session was over he left for this country with Liebig, who was to present the substance of that work as a Report to the British Association at Glasgow in September. You may be interested to know who there were from this country in Liebig's laboratory at that time. Besides Playfair and myself, there were Dr. William Allen Miller, afterwards Professor of Chemistry at King's College; Dr. Stenhouse, who has contributed so much to the Journal of this Society; Dr. Angus Smith; and, lastly, Dr. Edward Schunck. He and I are, I believe, the only survivors of that time among those from England who were with Liebig then. Of the Germans who were there, some of the names you will probably remember. There were Heinrich Will, Varrentrapp, Redtenbacher, Hermann Kopp, Scherer, Bromeis, Boeckmann, and others, of various nationalities; but I believe that not one of these survives at present. Schunck joined the Society early in 1842, and he from that time to this has devoted himself to scientific investigation. He built a laboratory, and a museum devoted especially to specimens of organic bodies, in his own grounds on the other side of Manchester, where he still lives. He was, in fact, the oldest member of the Society, I believe, except Playfair and myself. He has worked indefatigably ever since; but I am very sorry to say he is not able to be here to-night, having had an

attack of bronchitis, which renders it impossible, though it would have given him great pleasure to be present. Referring to that time at Giessen, I may say that Playfair, Stenhouse, and myself, each took our degree then; and Playfair, though joining with us, having gone with Liebig, the responsibility was left with Stenhouse and myself to give the usual supper to the other students of the laboratory, and a few distinguished guests, among whom was Bunsen, who was then at Marburg; and who, I am glad to learn from Sir Henry Roscoe, is still well. Stenhouse was much my senior. We had a large and lively party, but Stenhouse did not enjoy that sort of thing very much, and when the last bottle of champagne was opened, he said: 'Now, Gilbert, I shall leave you to it,' and away he went. That was, however, not near the end of the evening. They stayed a very long time, and we did not exchange the smoky atmosphere of the supper-room for the clearer air outside until early morning. We then went round the boulevards of the little town, the Germans singing students' songs, and coming in time to the hotel where Stenhouse lodged, we serenaded him from the outside. Then someone tried the door, and finding it unfastened, the whole party went up, lighted candles, and serenaded him in bed. Next morning, there was a very capital caricature brought out, showing Stenhouse's rather long nose pointing in one direction, and his longer nightcap in the other. But this is enough of this kind of history, and I must now turn to rather more serious matters. It was in 1843 that I became associated with Mr. (now Sir John) Lawes, in agricultural investigation—a collaboration which has now extended over more than fifty-five years. As you all know, however rude may be some of the methods of the art of agriculture, the investigation of the principles underlying its practices involves a wide range of scientific inquiry. It involves the chemistry of the atmosphere, of the soil, of vegetation, and of animal life and growth. That is to say, besides chemistry, it involves meteorology, botany, vegetable physiology, and animal physiology, to some extent. It is impossible to be a specialist in so many subjects, particularly in these days, and I can only say that in venturing to deal with these other branches of science we have taken great care to avoid mistakes. The wide range of the investigations must be accepted as some explanation of the fact that we have not contributed more of the results to the Chemical Society. Many of them being connected largely with other branches of science, have been recorded in other than purely Chemical journals; whilst those having a more directly practical bearing have been published in the Journal of the Royal Agricultural Society, or in other agricultural publications—the Rothamsted papers now numbering considerably more than 100. But we feel that, however long or short may be the time that we shall still work together, we shall perhaps have done as much in opening up as in

solving problems; and that we shall certainly leave plenty for our successors to do. In conclusion, considering that there still remain five of your honoured guests to speak, this is all I will say of my own career, and I will only now ask you, Mr. President, the Council, and the Fellows of the Chemical Society, to believe that I esteem very highly the great honour you have conferred upon me to-night."

SIR EDWARD FRANKLAND: "Allow me to thank you, Mr. President, and the Council of the Chemical Society for this delightful entertainment which you have prepared for the Past-Presidents who have attained Jubilee rank. It was a generous, unique, and happy idea, which I feel sure we all heartily appreciate, not only as we sit at your hospitable board, but also when we reflect on the kind feelings which led to the conception of that idea. There used to be a phrenological organ entitled 'love of approbation,' and whether there is or is not, a part of the brain told off to perform this function, I trust that chemists are not behind the rest of humanity in appreciating such an honour as you have conferred upon us on this auspicious occasion. Nothing could be more agreeable than thus meeting so many colleagues who are worthily keeping up the high reputation of the Chemical Society. There is but one drawback to our enjoyment, and it has been very feelingly alluded to by Sir Henry Gilbert, namely, that one who so recently stood at the head of our Past-Presidents should not still be present amongst us. In the lamented death of Lord Playfair, chemistry and science generally have sustained an immeasurable loss; for he was a binding link between science and the State, always ready to fight for the cause of truth against prejudice and ignorance, and never ceasing in his efforts to bring home to our rulers the vast importance of the applications of science to the progress, health and prosperity of the nation. As one of his first pupils, and after a life-long friendship, I may be permitted to testify that his energy in this cause was prompted by sincere convictions and not by political exigencies. Had Playfair lived a few months longer, we should never have had the misfortune to make the acquaintance of that new variety of *Homo sapiens* the 'conscientious objector,' who is just now giving so much trouble to our magistrates. This is not a time to sketch, even in merest outline, the epoch-making work of the Society, but I may at least state my conviction that it will be found, on comparing the volumes of our *Transactions* with those of the corresponding societies of other lands, that, considering the number of workers in each case, England is not behind any other nation in research work, and this in spite of the almost total absence of that lavish State aid which nearly every other civilised nation enjoys. In view of the vast number of discoveries pouring out from chemical laboratories, I hear it suggested that the day is not far distant when there will be nothing left to discover, when all the elements in the cosmos shall have been cap-

tured and fitted into the Periodic System of Newlands and Mendeléeff, when there is not one more gas in the atmosphere left to be detected, and every element and group of elements shall have its ortho-, para-, and meta-position assigned to it. What will then remain to be done? Fortunately for investigators, we shall still be only as children gathering pebbles on the shore of the great ocean of knowledge. As yet we have only found the big boulders. To change the metaphor, chemistry now occupies the position of geography a century ago. The enormous number of chemical compounds are like so many islands, their latitude and longitude ascertained with precision, but on which the foot of man has not been put down, whilst their animals, plants, and minerals have never been exploited. When the ideal state of knowledge has been attained, chemists will perhaps find time to explore this vast archipelago, in which, there is no doubt, many interesting discoveries await those who shall undertake the task. Who can set a limit to the usefulness of these explorations? Even the most unpromising compounds may turn out valuable prizes! When aniline, chloroform, and carbolic acid were discovered, who could have predicted the revolutions in the arts and surgery which these bodies were destined to produce! They were but as desert islands until they attracted the attention of Hofmann, Perkin, James Simpson, and Lister. As chemists, I believe we have a noble future before us. Chemistry is distinguished from all other branches of knowledge as the helpmate of nearly every other science. The geologist, the botanist, and the physiologist find no thoroughfare unless they call in the help of the chemist. As soon as the physicist breaks into a molecule, he is trespassing on our domain. The bacteriologist has found that it is not the wagging of the tail of a pathogenic microbe that is the most important feature of its history, but that the chemical compounds which it secretes demand his closest attention. Even the astronomer has already to sit at the feet of the chemist! Thirty-three years ago, when our worthy President was but a youth, there was once a dinner party composed chiefly of chemists held at the Albion. A few are still living—among them being Sir F. Abel, Prof. Odling, and myself. In an after-dinner speech on that occasion, my friend Abel is reported to have expressed himself in blank verse as follows: (I hope he will forgive me, at this distance of time, for appropriating his words to my own use).

“ ‘ Looking to right and to left, I see many faces around me,
 Faces so old and familiar I feel once again at the College,
 Testing, as in former times, for chlorine with nitrate of silver,
 Gazing with youthful delight at crystals just hatched in a beaker,
 Yearning o’er aniline drops distilling from crystal alembic.
 O! my dear friends, one and all, we have toiled up a difficult pathway!
 Some are low down on the hill, and others are near to the summit.
 Let us remember the past and forget not our absent companions;
 Fortune may come to us all; but youth will return to us never!’ ”

PROFESSOR ODLING: "I do not know that I can better commence the few observations I propose to make to you than by following in the wake of my predecessor, Sir Edward Frankland, and saying that it is no less a great pleasure than my bounden duty to express to you, Mr. President, and to the Council and Fellows of the Society my heartfelt thanks for the great compliment that you have paid to my colleagues and myself on this long-to-be-remembered occasion. Speaking, however, for myself personally, it is not the first time that I have had evidenced to me the kindly feeling of the Chemical Society. On the occasion of my retirement from the Secretaryship in 1869, I had also the special honour done me of being entertained at a dinner by the Society; and I also received a further token of their good will in the form of a capacious loving cup of no inconsiderable value in itself, but of far greater value as a perpetual mark of the kind feeling towards me of those with whom I had been for so many years so intimately connected. Those of us whom you entertain this evening have for a long period of time, as Sir Henry Gilbert and Sir Edward Frankland have already remarked, been associated with one another in common pursuits and enjoyments; and if there is one thing more than another that enhances to me the gratification of this meeting, it is the pleasure of finding myself associated still with my old friends and colleagues, Gilbert and Frankland and Williamson and Gladstone, and my earliest friend of all, Sir Frederick Abel. We have been concerned with one another in a large number of undertakings, and for a long period of time have been accustomed to hear one another's voices as well upon festive as upon scientific occasions. But we have not been accustomed to hear them in exactly the order they have been arranged for this evening. I have always looked upon myself, not as a precursor, but as a follower of Williamson. It has been my pride to reckon myself one of his adopted pupils—a disciple of his ideas more perhaps than many of those who were his actual pupils. He was always very decided in his notions. Sometimes, indeed, I turned a little restive, but was always soon pulled up into form again—sometimes more abruptly, perhaps, than was quite agreeable at the moment. At one time I laboured under the sad suspicion of being a little unsound as to the Atomic Theory. Well, perhaps I was not altogether so stalwart in its defence as I ought to have been; but I can assure you that I was never really guilty of so reprehensible a heresy as that which was attributed to me.

"You are doing us honour here this evening not so much, or not only, as students of the science of chemistry, but also as Past-Presidents of the Chemical Society. As ancients of that Society, we may all of us perhaps be permitted to talk a little about ourselves without incurring the imputation of egoism, and also to talk a little about old times without incurring the reproach, after our fifty years' fellow-

ship, of senile garrulity. At the period during which I acted as one of the Secretaries of the Society, and my colleague, Professor Redwood, concerned himself mostly with the business department of our affairs, the Chemical Society had not developed very far its function as a publishing agency, and as a consequence, even for that little prolific time, we did not get our fair share of important papers communicated at first hand to our meetings. But if we did not receive elaborate communications, we enjoyed the benefit of elaborate discussions; and there was no new class of compounds, no newly propounded doctrine, no new reaction which was not submitted to our keen examination and controversy. The subjects of several of those controversies, and even the fashion of them, still linger in one's memory. I need scarcely say that chemical theory came in for a large share of our attention. The molecular weights of water and carbonic acid, the atomic weights of oxygen and carbon, and, above all, the then newly introduced idea of polyatomic radicles were keenly discussed. We were a little too late for the interesting question as to whether compound radicles could possibly be oxygenous; but still, radicles were predominant at that time in chemical science, and reigned with undisputed sway over the whole domain of organic chemistry. One cannot but reflect how fleeting has been their reign. The doctrine of radicles has now sunk to an entirely subordinate position in chemistry, not unlike, may I venture to say, the subordinate position into which radical doctrines have fallen in a different sphere. There was one particular controversy I remember very well, and am sure Frankland will remember also. It was of this kind: whether the bodies called ethyl and methyl were really ethyl and methyl at all, or something else. Well, a question of that kind in those unsophisticated days had to be answered definitely by a plain aye or no. There was no loophole for escape or trimming, no possibility of saying that the one answer was just as true as the other, according to the point of view taken; nor was there existent in that period of innocence, for the solution of yet more puzzling problems, what we know now by the name of tautomerism, by which we learn that a body is, and at the same time is not, what it is alleged to be; that it is sometimes one thing and sometimes another, and sometimes both together, and yet preserves its individual chemical entity. In those days the principal provider of chemical material for our meetings was far and away Hofmann. He was in the habit of sending his multitudinous papers to the Royal Society for publication; but he gave us the advantage of his presence and his personal disquisitions; and I would appeal to all in this room who had the advantage of seeing him, to say if they can possibly forget his appearances at

the blackboard of the Chemical Society, and the enthusiasm and lucidity of his expositions of different points of chemical constitution, enlivened as they were by that extraordinary display of vivacity so inconsistent with the quiet phlegm we are in the habit of attributing to those of his nationality. But, despite the productiveness of Hofmann, still there were evenings on which something else was required; and then it behoved the Secretary to search far and wide for material to bring before the meeting of chemists who, with Greek-like avidity, were always clamorous for 'some new thing.' At that period, the activity of the Giessen school was somewhat on the decline, and we looked for novelties in chemistry, as for novelties in mantles and millinery, to Paris. We had for our consideration the acidic ammonias of Gerhardt and the diatomic glycols of Wurtz, and the production of alcohol without the aid of either sugar or yeast by Berthelot, and many other remarkable contributions to the knowledge of the day. But our friends across the water, with so much—so very much—justly due to them, nevertheless did manifest now and then a tendency to appropriate to themselves what did not altogether belong to them; and in this, the country of Black and Priestley and Cavendish and Dalton and Davy, we were astonished one fine morning at being informed that '*la Chimie est une science française.*' But even with the productiveness of Hofmann and the searchings of the Secretary, it did sometimes happen that our bill of fare was a little meagre. But what of that? Those were supper-eating days, and a meeting rendered brief by want of pabulum could always be supplemented by a prolonged and substantial, and, I may add, a musical, meal at a then well-known resort not far from Covent Garden; and when it happened, as it did sometimes, that our proceedings were not so exhilarating as they should have been, when divine philosophy had proved less charming than its wont, Hofmann, despite the abundant supply of tea and coffee of excellent quality, would, with a burst of inspiration, thrust forth his right hand and say: 'I will tell you, we will have a punch!'

"But the Chemical Society has a future to look forward to, as well as a past to look back upon. At the Jubilee of the Society some seven or eight years ago, it devolved upon me to give an account within the short period of a quarter of an hour—I believe I occupied twenty minutes—of the progress of chemical science during the preceding fifty years. But to-day is also a Jubilee or almost so, the Jubilee of our incorporation by Royal Charter, which, in the then days of our insignificance, Playfair did so much to obtain for us. Now, on this diamond Jubilee, I ask you how many minutes will you give me to lay before you a forecast of the chemical progress that may be expected to take place within the next fifty years? I will only venture to say that,

judging by the number and activity and intellectual gifts of the workers of the present day, we may feel assured that the achievements of English chemistry and the progress of the Chemical Society in the past, will be as a mere nothing to the brilliancy to which they will attain in the future."

SIR FREDERICK ABEL: "Sir Edward Frankland has out of his vast stores of knowledge recalled a fact of which I confess I was ignorant, that in years past I indulged a poetic fancy. I only wish I might now be inspired in order to find words to express on behalf of myself and my old friends our appreciation of this glorious reception which you have given us. The Chemical Society is endeared to me in many ways. Among the epochs of a somewhat long career of ceaseless activity, that which connected me intimately with the work of the Society is one of those which I recall with the greatest pleasure and satisfaction. And it so happens that the years of my connection with the Society in various functions were years in which some of the most memorable events in its annals occurred. As Treasurer, it was my privilege to arrange with the illustrious chemist and brilliant orator, Jean Baptiste Dumas, for the delivery of the first of those memorable lectures which were given through the agency of the Chemical Society in honour of the memory of Michael Faraday. While I was Treasurer, the volume of the Journal of the Society, which was then of modest and slender dimensions, nurtured by well digested extracts from foreign journals, speedily gained proportions unwieldy in character, so unwieldy, in fact, that the one volume split up into two before long. In the first year of my Presidency, the Research Fund, which was initiated in a modest manner by Mr. Thomas Hyde Hills, was placed upon a firm and substantial basis through the generosity of one of the most respected of the Society's original members, Dr. Longstaff; and in the second year in which I held that office, the somewhat revolutionary agitation which was persisted in by a not unimportant section of the younger Fellows of the Society,—an agitation which, by the way, has been imitated since—led to earnest deliberation and consultation between the Council and some of its chosen members outside the Council, which resulted in the birth of an institution now flourishing exceedingly, which has become the guardian of the best interests not only of the chemical profession but also of the public. I of course allude to the Institute of Chemistry of Great Britain and Ireland. When I look back to the early days when I first owned the proud title of F.C.S., and remember my attendance, in a small room at the Society of Arts, at the meetings of the Chemical Society, presided over in succession by William Brande and Phillips, the business being managed by

George Fownes and Robert Warington, the founder of the Chemical Society, and the funds not very cleverly handled by dear old Robert Porrett, one of the most prominent forms that appears in my mind's eye is that of the favourite pupil of Liebig, my venerated master, Hofmann. In the very first years of the Society, Hofmann became the very life and soul of it. He was beloved by his English brethren directly he came among them, and for years he was by far the most prolific contributor, either himself or through his pupils, to the volumes of the Society. Pardon me if I have been tempted into reminiscences; it is difficult to avoid it at such a gathering as this. The welcome you have given to the veteran Past-Presidents will remain in their minds to their last day as one of the great joys of their lives. To the many old friends and colleagues whom I see around me—Past-Presidents who, as men of science, hold positions second to none, whose names are familiar as household words—to them I can wish no higher gratification than that they may live to experience the satisfaction of such an entertainment, and of such a graceful appreciation of their work, as has been the lot of your old Past-Presidents to-night.”

PROFESSOR A. W. WILLIAMSON: “I thank you, Mr. President, most heartily for the kindly words you have uttered in relation to me, and to my efforts for the advancement of chemistry. It is an immense satisfaction to me to see a man of your talents and vast acquirements placed in so influential a position as that which you so worthily occupy. But whilst thanking you I am bound to confess that I have been for some time past a most unworthy member of the Chemical Society. It happened that after a good many years of work in our Society, I had other matters of such importance claiming my time and attention, that I was unable to continue to work amongst my colleagues and friends in the Chemical Society.

“Before I came over in 1849 to work at University College, I had become acquainted in the Giessen Laboratory with that most remarkable man, August Wilhelm Hofmann, and I may mention a characteristic incident illustrating his earnest and steadfast devotion to his science. He had for a considerable time been working at derivatives of aniline, and in order to carry on these researches as effectively as possible, he prepared by the action of caustic potash on indigo about some two gallons of aniline. The product was placed in a big bottle on the mantelpiece in his bedroom, and the story goes that he used to stand and gaze at it for some time every morning and evening, and gloating over it with delight would think, ‘what a number of splendid products I shall make out of this aniline!’ The energy and devotion with which he followed up his work on the derivatives of aniline at

the expense of many other researches which he might with advantage have followed up was such that he came to be talked of as the great worker on aniline, and Sir Benjamin Brodie somewhat prematurely wrote his epitaph in the following words, 'Hic jacet Aniline.' His researches extended, however, at an increasing rate into other and wider departments of chemistry, and his energy and enthusiasm were such as to make him the leading explorer in the domain of organic chemistry. Berzelius had been for a lengthened period the one great man in the domain of inorganic chemistry, which was the only part of the science which had been explored to any appreciable extent. When I saw the vast piles of knowledge which Hofmann was so rapidly accumulating in the new domain of chemistry, I felt, and ventured to say, that his masterly labours entitled him to be called the Berzelius of Organic Chemistry. I happened to be present at a meeting of the Chemical Society at which a young chemist read a paper in the presence of Hofmann on some theoretical matters of importance which had already engaged the attention of distinguished chemists. Hofmann did not enter into any particulars of the paper, but he gave vent to an outburst of heartfelt delight at the simple narrative which had been read. There are various incentives to work, but the most potent incentive to earnest and efficient work is probably the example of a man like Hofmann, whose whole delight lay in mastering the truths of science, and in learning more and more particulars of the order of nature, and Hofmann possessed that power in a most eminent degree.

"We see in this grand hall an assemblage of chemists known by their earnest labours and valuable discoveries, and we are honoured by the presence of men of the highest distinction in other branches of science, as well as of leaders in the learned professions. It might not be unreasonable to believe that enthusiastic delight in the triumphs of chemical research is duly represented by some of the guests in this hall, and that the lively conversation which has been going on may not relate merely to high questions in jurisprudence, medicine, or legislation, but that some samples of chemical enthusiasm may reach the ears of the learned representatives of other professions.

"I feel sure that at a future time we shall all look back with the highest pleasure upon this delightful evening, which we owe to the kindly exertions of our President and other leading members of the Society."

DR. JOHN HALL GLADSTONE: "It is a pleasant thing to look on the faces of so many friends with whom one has worked in olden times, with whose works one is well acquainted; though, of course, there are many at the present time who come into the Society, and whom I can look to as budding philosophers: unfortunately, I do not know their

names so well as their faces. The pleasure is not merely because we call ourselves chemists, but because there is a bond of union between us arising from the desire of discovering the wonderful secrets of the great cosmos of which we ourselves form part. There is a great difficulty in speaking to you this evening, because so much that I should have liked to say has already been said by previous speakers. Still there are one or two things which, if you will permit me, I should like to bring before you. First of all, in your too flattering description of myself and of my work—which makes me rather ashamed to stand up and speak—there was a point which I think calls for remark, and so I must venture upon that which characterises the speeches of all of us, a certain amount of early autobiography. I was exceedingly fond of science from a little child. My favourite science was geology, and also what could be seen in the microscope—infusoria, and other little objects we have heard of in later times. But, in choosing a profession, my father said geology was not a promising career, and recommended chemistry. I knew very little about it, but went to University College and studied under that admirable teacher, Professor Graham, and afterwards under Liebig. I suppose it was from Graham that I acquired the taste for the physical side of chemistry and its connection with heat, light, electricity, and other forces of nature. I looked out for a scientific position, and lectured at St. Thomas's Hospital for some time, made analyses, and considered myself a professional chemist. It may be that circumstances have caused me to sink into the position of an amateur chemist, but my first intention was that of following chemistry as my profession in life. It has not been necessary to continue that; and I have had this advantage, that I could always keep in my laboratory a good, trained assistant, and thus, whilst I was engaged in other works and ways, and in endeavouring to extend the knowledge of chemistry and elementary science in our primary schools, the work still went on more or less under my immediate direction. I should like to have said something about the progress of chemistry during these past fifty years; but the subject is so enormous, and you yourself have touched upon it to such an extent and so well, that I need only allude to the fact that this great change of volume of chemistry has caused it to be necessary that we should specialise. Specialisation has its advantages, but also its disadvantages. One danger is that we may become narrowed in our views. So it would appear to be best to have a home somewhere or other, but to make occasional excursions in the neighbourhood, and take summer holidays so as to get our nerves braced up to work again at our own pet subjects. I must not touch upon other points, such as the relations of the physical forces to

chemistry, or its useful applications, and the great value of chemical research for the welfare of mankind. These are subjects too large and important to enter upon at this late hour. It seems to me that while we are always increasing the mass of knowledge we possess, the space which we see to be bright becomes larger and larger, but there is beyond a dim nebulosity. It is our work to bring from that nebulosity something into the bright space, so that it becomes the property of the human race. But there is beyond this a region which we do not understand—infinite as far as we know—and our object is to increase that which is knowable, in the firm belief that it will be for the advantage of our fellow creatures. While I feel thankful for the joy that I have had in taking some part in these discoveries, I cannot look to have much more time given me for carrying on this work of investigation; but still there may be a few threads of old research I may gather up, and in doing so I shall be greatly encouraged by the kind remarks of this evening and the way in which our work has been received by the friends gathered around us.”

“THE FOREIGN MEMBERS.”

SIR WILLIAM CROOKES: “If it is possible for an after-dinner speaker to associate the word pleasure with the duty he has to perform, then I may lay claim to a slight feeling of that kind; for we are here assembled to do honour to our Past-Presidents, who are, as it were, now celebrating their jubilee in the Chemical Society. But it so happens that I also have a little jubilee of my own at this time, for exactly 50 years ago I made my first step in science by entering the Royal College of Chemistry. I remember as if it were yesterday, on a dull November morning, being introduced to Hofmann, who forthwith installed me at a bench, and asked Spiller, who was a few weeks my senior in science, to put me through the gases, preliminary to a course of the ‘Giessen Outlines.’ These were the days of compound ammonias, and heating in sealed glass tubes under pressure; having a certain facility at the blowpipe, I used to seal up some of these tubes; many of them, I fear, burst, for I well remember Hofmann’s quaint remark, while watching one of them with anxious eyes, ‘I think, Mr. Crookes, it will now gradually commence to explode violently.’

“One of the great troubles of a long life is to see the friends of early days drop off one by one. Of those in the College when I entered, I know only of Abel, Buckton, Dent, Spiller, and one or two others. It is a special pleasure for me to be here to-night and join in doing honour to one of these—my oldest scientific friend—Sir Frederick Abel. But in these reminiscences I must not forget my duty. I am

asked to propose the health of the Foreign Members of the Society. There is a little topsyturveydom about this arrangement. I am saddled with a burden to which I have only a doubtful right. Such a toast can only be proposed by a Fellow, but when, some time ago, I approached your senior Secretary in that capacity, he refused to regard me in this light, and said I could only dine among you as a visitor.

"But the occasion is so special that, as a visitor, outsider, or Fellow, it must always be a great pleasure to propose the toast of the Foreign Members. We have a large roll of Foreign Members on our list. They are very eminent men; and, as proof, I need only mention that on this special occasion they are so busy with scientific work that few are able to come to join us to-night. But we have amongst us one of the most eminent of Continental chemists—Professor Ostwald—whose name is a household word to us all, and I will ask him to take the burden of replying to this toast."

Professor OSTWALD: "The task laid upon my shoulders is so heavy that I cannot bear it in a foreign language. I must ask you, therefore, to allow me to answer in my own. Als ich die ehrenvolle Einladung für den heutigen Tag erhielt, war ich sofort bereit zu kommen. Nicht weil ich eine grosse Zahl guter Freunde und werthvoller Dinge in London sehen konnte; ich kam um eine grössere Sache. Ich kam, um Zeugniß abzulegen von der Gemeinschaft der wissenschaftlichen Männer aller Nationen. Das Fest, welches Sie feiern, hat seinen Anklang in der ganzen Welt gefunden; die wissenschaftliche Internationalität bringt es mit sich, dass des heutigen Tages überall gedacht wird, wo Chemiker sind.

"Meine Herren! Die Wissenschaft ist ein Land, welches die Eigenschaft hat, um so mehr Menschen beherbergen zu können, je mehr Bewohner sich darin sammeln; sie ist ein Schatz, der um so grösser wird, je mehr man ihn theilt. Darum kann jeder von uns in seiner Art seine Arbeit thun, und die Gemeinsamkeit bedeutet nicht Gleichförmigkeit. Wir werden immer an unseren französischen Arbeitsgenossen die Klarheit ihrer Darstellung und die Strenge ihrer logischen Entwicklung bewundern. Die Originalität der Gedanken und die unwiderstehliche Energie ihrer Durchführung wird stets die englische Forschung auszeichnen, und wenn wir Deutsche 'durch die Welt mit allen Sinnen schweifen,' um für unsere Arbeit eine möglichst breite Unterlage und einen möglichst weiten Horizont zu gewinnen, so thun wir darin auch nur, was unserer Natur entspricht.

"Hierzu möchte ich aus unserer Wissenschaft ein Beispiel entwickeln. Es ist ein wichtiges Resultat der heutigen Forschung, dass es nicht möglich ist, einen absolut reinen Stoff herzustellen. So rein er auch wird: die letzten Spuren seiner Mutterlauge können

nicht entfernt werden, und er trägt immer ein Zeugniß seiner letzten Geschichte mit sich.

“Nun, meine Herren, in der Chemie des Geistes gilt ein ähnliches Gesetz. Auch der klarste Gedanke, die durchgearbeitetste Theorie trägt Spuren der Umgebung mit sich, aus der sie entstanden ist. Wenn nun der Fremde den neuen Gedanken zum ersten Male zu Gesicht bekommt, und er gefällt ihm nicht, so wird er sich zunächst nicht bewusst sein, ob der abstassende Eindruck von dem Gedanken selbst, oder von der anhängenden Mutterlauge herrührt, und es kann kommen, dass er ihn verwirft, nicht wegen seiner eigenen Beschaffenheit, sondern wegen zufälliger Beimengungen. Wenn ihm aber jenes *Gesetz der geistigen Mutterlauge* bekannt ist, so wird er sorgfältiger prüfen, und manches Vorurtheil, welches die gemeinsame Arbeit der Nationen stört, wird fallen.

“Für diese Gemeinsamkeit bietet gerade der heutige Abend einen ausgezeichneten Beleg. Als ich die Geschichte meines besonderen Gebietes, der Verwandtschaftslehre studirte, fand ich aus sehr früher Zeit eine Reihe hochwichtiger Arbeiten, durch welche eine Anzahl fundamentaler Thatsachen festgestellt wurden. Die Arbeiten trugen den Namen des Dr. Gladstone. Ich habe vergeblich darauf gewartet, dass heute Abend diese Arbeiten erwähnt würden. Es ist nicht geschehen, und ich glaube, Dr. Gladstone hat selbst vergessen, dass er sie gemacht hat. Aber wenn er sie auch selbst vergessen hat, die Wissenschaft wird sie nie vergessen. Und wenn jetzt, nach soviel Jahren, die Wissenschaft in Schweden, Holland, and Deutschland den Faden dort weitergesponnen hat, wo Dr. Gladstone in England ihn aus der Hand gelegt hat, so haben Sie ein schlagendes Beispiel vor sich, wieweit über Raum und Zeit die wissenschaftliche Gemeinsamkeit aller Forscher reicht.”

“THE LEARNED SOCIETIES.”

LORD REAY: “I have seldom had the honour of proposing a toast to so distinguished an assembly, and at the same time a toast which, whether it was proposed at St. Petersburg, at Berlin, in Paris, in Vienna, or in Rome, coupled with the names with which it is coupled to-night, would attract the same applause. Lord Lister has conferred on the House of Lords, in entering it, an additional dignity. If we are asked—and we are occasionally asked—why there is a House of Lords, I do not know that we can give any better answer than by saying that the House of Lords is the proper place for receiving the princes of science. And, gentlemen, among the characteristics of the House of Lords there is one to which I shall allude; one which I consider a very important characteristic. If I ask what are the characteristics of the House of Commons—what are the characteristics of those

who wish to enter the House of Commons,—then I am told that the catechism to which one has to answer is: ‘Are you sound on Labour?’ Now I am not quite sure that I fully grasp what is meant by soundness on Labour. But the problem may be solved when the House of Commons approaches a task which I know would tax the efforts of all the learned societies in London to deal with—the question of old age pensions. What is the catechism of the House of Lords? I think the question would be: ‘Are you sound on Science?’ I believe the House of Lords is sound on science, and in the contests of the future between prejudice and the laws of science, I think you will find, as you have found in the recent debate on vaccination, that the House of Lords will be on the side of Science, and not on the side of prejudice. And if the House of Lords is to remain sound on Science, then it will be due to having in it; midst men like my noble friend, Lord Lister, to keep it straight whenever it may show any inclination to diverge from the dictates of Science. There is hardly any subject at present in any department of the public service in which the question of science does not play a prominent part. And I do not believe that there is any department of the public service which does not occasionally seek the aid of a learned society on one or other of the scientific problems it has to solve. My late distinguished friend, M. Léon Say, used to predict of the twentieth century that Cabinets would be formed on the basis of sanitation. If so, we may still hope to see my noble friend, Lord Lister, at the head of the Home Office.

“With this toast is also coupled the name of my friend Professor Michael Foster. Mr. President and gentlemen, it is to me personally a great pleasure to couple with this toast that name, because the future of scientific education in London is committed to the care of Professor Michael Foster. The Statutory Commission, I hope, will set at rest that interminable controversy about the reconstitution of the University of London, and to Professor Michael Foster will fall the duty of settling the future of Science in that institution, which will influence the future of Science in our great empire. Let me conclude with an observation, which is the result of what fell from the eloquent lips of the gentleman who last addressed us. He has spoken of ‘die wissenschaftliche Internationalität.’ I heard those words with great pleasure. Whatever causes of discord may disturb international relations, it will be among the great features of the work of the Learned Societies that they will always entertain cordial relations with the learned men in all foreign countries. And, Mr. President and gentlemen, whatever may happen on the banks of the Nile, of this I am sure, that the cordial relations which have existed between my distinguished friend, Professor Ramsay, on the banks of the Thames and Monsieur Berthelot on the banks of the Seine, will remain the same

and tend to knit together that which ought never to be separated if the progress of civilisation is not to be interrupted. I give you the toast of 'The Learned Societies,' coupled with the names of Lord Lister and Professor Michael Foster."

LORD LISTER: "Scientific men are not by any means always learned. Their devotion to their special studies often prevents such an occurrence. Nevertheless, I take it that in this toast the Learned Societies are understood to mean the scientific societies, and chiefly those of this metropolis. On this understanding, it seems to me very natural that the person who is asked to respond to this toast should be a representative of the Royal Society, because that Society is the mother of all the scientific societies in London; and while, if I may be allowed to say so, she is herself vigorous and active, she takes a deep maternal interest in the welfare of her offspring. Of her numerous progeny, none, I conceive, discharges her functions more healthily and efficiently than she who is this evening honouring some of her most illustrious and venerable sons. Among these it has been my joy to see my old teacher, the venerated and beloved Professor Williamson. The Royal Society, I believe, does good to her daughters, stimulating them to work, and encouraging fruitful intercourse among them: witness, for example, the discovery of argon by the co-operation of Lord Rayleigh and Professor Ramsay. Mr. President, I received from one of your Secretaries an intimation that brevity would be the most valuable quality in any remarks I might make this evening. I gladly act on that suggestion, and will only now tender to you and your Council, on behalf of the representatives of scientific societies, other than the Chemical Society, present here this evening, our warmest thanks for the privilege you have given us of taking part in this memorable celebration. I would also thank Lord Reay for the exceedingly kind terms in which he has proposed the toast, and this illustrious company for the cordial manner in which they have received it."

PROFESSOR MICHAEL FOSTER: "I feel deeply grateful for the very kind words in which Lord Reay has referred to me and my possible future services, in which I trust he may not be disappointed, and for the kind way in which you have received the toast. I perceive the delicate compliment to my physiological acquirements in the inference that, although a President as yet unborn, I can speak. I did not know, in accepting office, that the sweets of office would come thus before their time. I trust that they will be taken off, so to speak, at the other end of the bill. But remembering that all premature utterances, whether vocal or other, are feeble, the more feeble, the more premature they are—and it seems to me that, as President of the British Association, I was conceived the other day—though I would have wished had not this premature deliverance been coupled with great lateness of the hour,

to have turned from an uncertain and dim future to a rich and full past, and to have said something of my experience of these six great men, all of whom I can call my friends, and one of whom—Williamson—taught me not only chemistry but science, I will content myself in saying this, that though I do not know what may be before me as President of the British Association—do not know what lions, true lions, false lions, there may be in my path,—I will do my best to make my tenure of office worthy, not only of the Association, but of Science. And may I also give utterance to this wish, in continuance of that international science of which my brother Ostwald spoke, that when the British Association meets at Dover, and the French Association meets at Boulogne, we shall feel that Fashoda is past over, and that we shall not be using the resources of science to make each other as small as we can, but that each will be using the strength of the other to advance the resources of a common knowledge.”

“THE GUESTS.”

THE TREASURER: “I have the honour to propose to you, Fellows of the Chemical Society, that you should drink to the health of your guests. We are favoured here to-night with the presence of a large and distinguished body of gentlemen; how large, and how distinguished, you yourselves may know by a mere glance at the list of their names which is already furnished to you. We are deeply grateful to these gentlemen for the way in which they have responded to the invitation of the Society to be present here to-night to do honour to the gentlemen who are our special guests. Large as the number is, we could well have wished that it was still larger; for our hospitality and our welcome have their physical limits only in the capacity of this room. We could well have wished, for example, that a greater number of our Foreign Fellows were here present. You have heard from the President many messages of congratulation and of goodwill from certain scientific organisations abroad, and from individual Fellows of our Society. But these messages by no means account for all the kind words, for all the utterances of friendship and felicitation, which have been made in reference to this occasion. I have recently passed through many Continental capitals, and have visited incidentally a number of academic centres, and I have had the pleasure of meeting a considerable proportion of those gentlemen whom we are proud to number amongst our Foreign members. Thus, I have met Franchimont at Leiden, Cleve at Upsala, Waage at Christiania, Pettersson and Arrhenius at Stockholm, Emil Fischer, Landolt, and van’t Hoff at Berlin, Liebermann and Witt at Charlottenburg, Ladenburg at Breslau, our active collaborateur Brauner at Prague, our old friend Debus in Cassel, and last, but not least, the

doyen of the illustrious body, my venerated teacher Bunsen, at Heidelberg. And, gentlemen, I am charged by each and all to convey to you, should I have the opportunity, their heartfelt congratulations on this occasion, and their great regret that circumstances should have prevented them from being here to testify by their presence their appreciation of the great services which these gentlemen whom we especially delight to honour to-night, have rendered to Science, and to the Society of which we are so thankful to see them still members. I should like to say an additional word or two about Bunsen. His Excellency has learned to grow old gracefully. He bears the weight of his eighty-eight years admirably. His deafness, it is true, has somewhat increased, and he complained with a touch of pathos which, under the circumstances, has just a suspicion of the element of comedy, that 'he begins to find that his eyesight is not so good as it used to be.' It was for this reason that he asked to be excused from conveying in writing the message which he wished me verbally to transmit to you. I am asked to associate with this toast the name of Mr. Haldane and that of Dr. Böttinger. Mr. Haldane is known to all here for the admirable part he has taken in furthering a cause which many of us have very near at heart—that is, the advancement to its legitimate position of our Metropolitan University. Dr. Böttinger is known to many here as a leading member of a firm whose name is as a household word in the mouths of those who speak of the material and industrial triumphs of our science. Gentlemen, without further word, I give you the health of 'Our Guests,' and I associate with that toast the names of Mr. Haldane, Q.C., M.P., and Dr. Böttinger."

MR. HALDANE: "I confess I feel a little shy in uttering the few sentences which I have to address to you. Previous speakers have come before you with a wealth of distinctions and a profusion of academic tone which it is impossible for me to imitate. Lord Reay, who represents a different branch of the Legislature, has put me to shame, by telling me, that the House of Lords is 'sound on science.' Well, I am glad hear it, and I wish I could say as much for the House of Commons. I cannot speak to you as a man of science, nor as a representative of any department of abstract knowledge; I can only speak to you as a humble,—that most humble of all functionaries,—unofficial member of an Opposition, or what I fear some of you will consider, a battered and shattered fragment of a still more battered and shattered Party. I do not admit, needless to say, the impeachment. I do not regard myself in the least as an atom which has got outside its proper molecule. There is plenty of potential energy in my political combinations. When I was at the University of Göttingen, there was a song we used to sing, which ran "Die Philister sind uns gewogen meist." Even

members of the House of Commons acknowledge the deep debt they are under to-day to science, and perhaps most especially to chemical science. Gentlemen, there was a great victory won the other day in the Soudan. That victory was due to the forethought and skill of a very distinguished soldier: but also to another force. That victory, which pronounced once for all, and finally, the supremacy of mind and trained skill over the most powerful of savage combinations; that victory was won, not merely on the fields before Omdurman, but in the laboratory and the workshop. The smokeless powders, the modern rifling, the bullet of most recent construction, all these are your work. But the obligations which you have rendered us in the past are as nothing to the obligations to which some of us look forward to you in the future. We have spent money lavishly, without a word of complaint, from the taxpayer, on the support of the Army and the Navy; but we have not yet spent the money which I believe we ought to spend, and shall be forced to spend, upon the defence of our industries. The country from which Professor Ostwald comes can teach us a lesson. In Germany, where 70 per cent. of the upkeep of the universities comes from the Government, they have taught us how to put mind into our work. There are men who would gladly convert the British public to it, but their work is yet to be done. We shall realise these things, when the House of Commons will vie with the House of Lords in giving predominance to the great task of diffusing scientific knowledge among our commercial men as among our soldiers. It is with that sentiment in my mind, with that feeling of obligation to these pioneers of the work of the members of this Society, that I gratefully thank you for the toast which has been proposed."

Dr. BÖTTINGER: "Allow me also to thank you most heartily and sincerely for the great honour you have conferred upon your guests by your kind invitation, and by putting them in a position to take part in this beautiful festival on the celebration of six Masters of English Science. Gentlemen, I may also thank you, most especially in my own name, for the great honour you have conferred upon me in mentioning my name specially among the toasts of the evening. I shall not forget this evening; it will always be in my mind a pleasant recollection of what Professor Ostwald said of you. In science we know no bounds and no boundaries internationally, for we are one great common nation. Your esteemed President, Professor Dewar, cordially remarked on the character of the messages you have received this evening from all parts of the scientific world. Allow me to add to these, and assure you that not only from the scientific world, but elsewhere these feelings are shared with the same heartiness with respect to the great work these gentlemen have done for the development of science and for the benefit of the human race. It is for me

a particular pleasure to see by the list of your numerous members and guests that you also acknowledge that science and industry and technique must go hand in hand ; that we who reap the technical part must rely upon the men of science for new ideas and advancement of our work. But I believe and am convinced that the men of science in their connection with us also find new initiative for the furtherance of their ideas ; they also find that in connection with the industrial and technical world they see what is further necessary for the development of their work. I am sure that the names of these six illustrious scientific men will be mark-stones in the world for the future, they will be stepping-stones for the new generations. Before I end, allow me to deviate from your English custom, and introduce a custom with us in Germany, a custom which is always followed with great enthusiasm, and to propose now the health of one whom particularly we have to thank for this beautiful evening : it is the health of a man who is a pioneer in science also, and has a great name. I need only remind you of liquefied air. I speak of Professor Dewar, and I ask you to join with me in a hearty three cheers for him. So take your glasses and join with me in our German fashion with Hoch ! Hoch ! Hoch ! ”

THE PRESIDENT: “My Lords and Gentlemen,—I must protest against the intrusion of an additional toast. We have had a most delightful evening ; we have achieved our great aim ; and I think that the present President is such a nonentity in comparison with the men we are here to honour, that the less said about him the better.”

Letters, telegrams, and messages of congratulation were received from the following Foreign Members:—Professors Arrhenius, Stockholm ; von Baeyer, Munich ; Beilstein, St. Petersburg ; Berthelot, Paris ; Lecoq de Boisbaudran, Paris ; Bunsen, Heidelberg ; Cannizzaro, Rome ; Cleve, Upsala ; Curtius, Bonn ; Erlenmeyer, Aschaffenburg ; Fischer, Berlin ; Fittig, Strassburg ; Franchimont, Leiden ; Friedel, Paris ; Wolcott Gibbs, Cambridge, Massachusetts ; Graebe, Geneva ; van't Hoff, Berlin ; Körner, Milan ; Ladenburg, Breslau ; Landolt, Berlin ; Liebermann, Berlin ; Lieben, Vienna ; Markownikoff, Moscow ; Mendeléeff, St. Petersburg ; Menschutkin, St. Petersburg ; Moissan, Paris ; Nilson, Stockholm ; Pettersson, Stockholm ; Rammelsberg, Berlin ; Raoult, Grenoble ; Remsen, Baltimore ; Schloesing, Paris ; Spring, Liège ; Thomsen, Copenhagen ; Troost, Paris ; Waage, Christiania ; van der Waals, Amsterdam ; Wislicenus, Leipzig ; Witt, Charlottenburg, and from a number of distinguished Fellows and friends of the Society.

A special vote of congratulation was passed by the Russian Chemical Society, and transmitted by Professor Mendeléeff.

“At a meeting of the Russian Chemical Society held this day, it was resolved, that the Society avail itself of the exceptional oppor-

tunity of being able to congratulate conjointly Sir Joseph Henry Gilbert, Sir Edward Frankland, Professor Odling, Sir F. A. Abel, Dr. A. W. Williamson, and Dr. J. H. Gladstone, whose distinguished services during half a century stand out as a model for all investigators in Chemical Science, and also express the wish to see the further results of their labours in the annals of Science for many years to come.

Hon. President, D. MENDELÉEFF.

Secretary, A. GORBOFF.

St. Petersburg, $\frac{20 \text{ May}}{1 \text{ June}}$ 1898."

The following telegram was received from the German Chemical Society. "The sister Society sends both Jubilee congratulations and greetings to the Jubilee celebration of the Presidents of the Chemical Society, Gilbert, Frankland, Odling, Abel, Williamson, and Gladstone. The German Chemical Society, C. LIEBERMANN, President."

November 17th, 1898. Professor Dewar, F.R.S., President, in the Chair.

Certificates were read for the first time in favour of Messrs. William Harcourt Branscombe, Verona, Eastbourne; Harry Estcourt Estcourt, Hayesleigh, Old Trafford, Manchester; George Cecil Fry, 1 Edinburgh Terrace, Newbury, Berks; John Golding, 1 Balmoral Road, Nottingham; Henry Winstone Harper, M.D., Austin, Texas, U.S.A.; James Hembrough, 159 Hotwell Road, Clifton, Bristol; Alfred Lucas, Maison Hussein Pasha, Cairo, Egypt; Samuel Montagu Martin, Westwood, Princetown Road, Bangor, co. Down; James Henry Pizey, 9 Lady Somerset Road, Highgate Road, N.W.; Robert Coleman Price, Blacksburg, Virginia, U.S.A.; Frederick Soddy, Merton College, Oxford; Louis Heathcote Walter, 83 Holland Park Avenue, W.; William Arthur Williams, 75 High Street, Wapping, E.

The following Candidates are recommended by the Council under Bye-law I (3):—Charles Robert Carroll, Hyderabad, Deccan, India; William Lash Miller, B.A., Ph.D., The University of Toronto; Frederick Louis Wilder, Villa Nova de Lima, Minas Geraes, Brazil.

The following papers were read.

133. "Determination of the constitution of fatty acids. Part I."
By Arthur W. Crossley and Henry R. Le Sueur.

The paper gives a detailed account of experiments undertaken with the idea of devising a method for the determination of the constitu-

tion of fatty acids. An acid, $\text{CH}_2\text{X} \cdot \text{CH}_2 \cdot \text{CO}_2\text{H}$, is first converted into the ethylic salt of the monobromo-derivative, $\text{CH}_2\text{X} \cdot \text{CHBr} \cdot \text{CO}_2\text{Et}$, which is then treated with quinoline or diethylaniline, whereby the elements of hydrogen bromide are removed, and the ethylic salt of an unsaturated acid of the acrylic series, $\text{CHX} \cdot \text{CH} \cdot \text{CO}_2\text{Et}$, is produced. The acid obtained by hydrolysing this salt is oxidised with potassium permanganate, giving rise to the corresponding dihydroxy-acid, $\text{CHXOH} \cdot \text{CHOH} \cdot \text{CO}_2\text{H}$, which is then oxidised with chromic acid, with the production of the acids $\text{X} \cdot \text{CO}_2\text{H}$ and $\text{CO}_2\text{H} \cdot \text{CO}_2\text{H}$. A fatty acid (or ketone) containing 2 carbon atoms less than the original acid has thus to be identified, and as the number of isomerides decreases greatly with loss of two carbon atoms, the possibility of identification is much enhanced.

The method has been carried out with valeric, isovaleric, and isobutylic acids with good results, the products identified being propionic acid, acetone, and isobutyric acid respectively.

The authors propose to continue the investigation with higher fatty acids, such as ethylisopropylacetic and stearic acids, and with a dibasic acid, such as pimelic (isopropylsuccinic) acid.

134. "The crystalline form of iodoform." By William Jackson Pope.

Considerable difficulty is experienced in obtaining iodoform in well developed crystals from solutions in the ordinary organic solvents, but it separates from acetone in magnificent six-sided tablets belonging to the hexagonal system. The crystals exhibit the forms $c\{111\}$, $r\{100$, $22\bar{1}\}$, $p\{\bar{1}10\}$, and $m\{2\bar{1}\bar{1}\}$, and have the axial angle $\alpha = 93^\circ 41'$; the double refraction is negative in sign and strong.

135. "The characterisation of racemic compounds." By Frederic Stanley Kipping and William Jackson Pope.

Having previously shown that crystallographic data afford a sure basis for the characterisation of racemic compounds, the authors now give the results of their examination of a method suggested and made use of by Ladenburg for this particular purpose.

Ladenburg stated (*Ber.*, 1894, 27, 3065) that if, on fractionally crystallising a mixture of an externally compensated substance with excess of one of the active constituents, the various fractions differ in specific rotation, the existence of a racemic compound is established; if, on the other hand, the various fractions have the same specific rotation, then the existence of a racemic compound is disproved.

The authors point out that the argument upon which Ladenburg's method is based is fallacious, and, further, on examining experimentally several cases of mixtures of an externally compensated substance with an excess of one of the optically active isomerides, they find that the method is valueless.

Mixtures of the non-racemic inactive sodium ammonium tartrate with the isomeric dextrotartrate, and of the racemic inactive sodium potassium tartrate with the corresponding dextrotartrate, were fractionally crystallised, and it was found that in each case the excess of dextrorotatory salt separated out first, most of the externally compensated substances remaining in the mother liquors.

136. "The occurrence of orthohydroxyacetophenone in *Chione glabra*." By Wyndham R. Dunstan and T. A. Henry.

The wood of *Chione glabra*, a large flowering tree indigenous to Grenada, has a strong aromatic, somewhat faecal, odour. This is due to a volatile oil which the authors find is chiefly composed of *ortho-hydroxyacetophenone*, $C_6H_4Ac \cdot OH$. The oil also contains a minute amount of what appears to be the crystalline methyl ether of this substance, $C_6H_4Ac \cdot OMe$.

The properties of orthohydroxyacetophenone, prepared in the laboratory from orthonitrocinnamic acid as a starting point, agree precisely with those of the volatile oil of *Chione glabra*.

DISCUSSION.

In reply to Dr. Harden, Professor DUNSTAN said that he thought the degradation of vegetable proteid a possible mode of origin of indole derivatives, though some botanists were of opinion that it was more probable that they resulted from simpler synthetic processes.

137. "Preparation of hyponitrite from nitrite through oxyamidosulphonate." By E. Divers and T. Haga.

The authors have already published, disconnectedly, the facts (1) that sodium nitrite can be very completely and easily changed into oximidosulphonate by dissolving it with the calculated quantity of sodium carbonate and passing sulphur dioxide into the solution; (2) that sodium oximidosulphonate can be hydrolysed very exactly into oxyamidosulphonate; and (3) that sodium oxyamidosulphonate can be largely decomposed into hyponitrite and sulphite by dissolving much potassium hydroxide in its concentrated solution. Details are now given by which, taking advantage of these facts, sodium nitrite

can be converted into 60 per cent. of its equivalent of silver hyponitrite. The essential points are to keep the temperature at 0° during the sulphonation of the nitrite; to allow the oximidosulphonate to hydrolyse, in the absence of sulphite, at or near the common temperature, during about 24 hours, so as to produce only oxyamidosulphonate and acid sulphate; to neutralise the solution by alkali carbonate, then dissolve in it sufficient potassium hydroxide to make the solution one of about equal weights of the hydroxide and water (having taken care from the first to use as little water as possible), and allow the whole to stand during 30 hours; to fractionally precipitate the hyponitrite by silver sulphate (or nitrate) from the greatly diluted alkaline solution, leaving the sulphite and the alkali in solution; to separate the silver hyponitrite from the metallic silver, &c., which accompanies it, by dissolving it in very cold dilute sulphuric acid, then filtering, and finally neutralising the sulphuric acid by sodium carbonate with the greatest expedition. Some oxyamidosulphonate always escapes decomposition by the potassium hydroxide; of that decomposed, about 80 per cent. becomes hyponitrite, and the rest nitrous oxide and alkali, besides, of course, sodium sulphite in either case.

138. "Absorption of nitric oxide in gas analysis." By E. Divers.

A concentrated alkaline solution of sodium or potassium sulphite absorbs nitric oxide completely and quickly, forming with it alkali (hypo)nitrososulphate, and can be used in gas analysis with satisfactory results.

139. "Interaction of nitric oxide with silver nitrate." By E. Divers.

Silver nitrate decomposes freely in a current of nitric oxide at much lower temperatures than when heated in air or carbon dioxide. The products, apart from oxygen, are the same, namely, nitric peroxide, silver, and silver nitrite, except that the silver nitrite is, for a time, an abundant product in presence of nitric oxide, whereas in its absence, when the temperature of decomposition is much higher, only a little of the nitrite is ever found, because it passes probably into nitric peroxide and silver nearly as fast as it is produced.

Either nitric oxide acts directly upon the silver nitrate, or, what is more probable, the imperceptible decomposition of silver nitrate alone, at temperatures of $220-250^{\circ}$, into oxygen and nitrite becomes rapid and marked in presence of nitric oxide, in consequence of the latter taking up oxygen as fast as it is formed by the decomposing nitrate.

Nitric oxide has no effect on heated sodium, potassium, barium, and lead nitrates.

140. "Preparation of pure alkali nitrites." By E. Divers.

Alkali nitrites are easily obtained pure and in concentrated solution by passing nitrous gases containing slight excess of nitric oxide into concentrated solutions of pure potassium or sodium hydroxide or carbonate, out of contact with air. With ordinary care, no nitrate is formed; it is a current mistake to suppose that it is.

Both nitrites are slightly yellow, and their concentrated solutions markedly yellow. The sodium salt melts at 213° ; at 15° , 6 parts of water dissolve 5 parts of it. Its crystals are often very large, but very thin, flattened prisms, moderately deliquescent. Sodium nitrite can be readily purified by recrystallisation; potassium nitrite cannot. Potassium nitrite occurs only in minute, short prisms, and is soluble in one-third of its weight of water. It is exceedingly deliquescent, but its crystals are actually anhydrous, although Lang and Hampe independently found them to contain $\frac{1}{2}\text{H}_2\text{O}$.

DISCUSSION.

MR. GROVES remarked that sodium nitrite is manufactured on a large scale for use in the colour industry, and is sent into the market nearly pure, containing some 98 per cent. of the salt, but as far as his experience went neither the salt nor the solution is yellow.

He had found that when arsenious anhydride is heated at 70° with nitric acid of sp. gr. 1.3, nearly pure nitrous anhydride, mixed only with a little nitric oxide, is evolved, and that a dilute solution of nitrous acid could readily be prepared by passing this vapour into water at 0° containing some crushed ice.

141. "The reduction of an alkali nitrite by an alkali metal." By E. Divers.

Nitrous oxide, nitrogen, hydroxylamine, ammonia, sodium hyponitrite, and sodium hydroxide are invariably products of the reduction of sodium nitrite by sodium amalgam, but the process can be modified so that each of them in turn shall be formed in any desired quantity between a very small amount and a certain maximum. The principal points needing attention are the degree of concentration of the solution and the temperature at which the reduction takes place.

The quantity of hyponitrite will be equivalent to more than one-sixth of the nitrite when the solution is concentrated and is not

allowed to grow too hot ; by large dilution, alone or aided by heat, it can be made indefinitely small. That of hydroxylamine may be made to be anything between one-eleventh and one three-hundredth of the equivalent of the nitrite, sufficient dilution and cooling being the conditions for a high yield of hydroxylamine. Ammonia being merely reduced hydroxylamine, its yield depends on that of hydroxylamine and reduction of this by the further action of the amalgam. The temperature at which the reduction is allowed to proceed determines how much of the gaseous products shall be nitrous oxide and how much nitrogen, high temperature causing the production of nitrogen. The two gases together are always nearly equivalent to a little more than four-fifths of the nitrite.

Sodium amalgam is entirely without action upon sodium hyponitrite. It has always very little action, if any, upon nitrous oxide at the common temperature. Sodium hyponitrite in concentrated sodium hydroxide solution is very stable and may be heated at 100° without effervescing. During the reduction of the nitrite, the gases produced may be seen to come exclusively from the surface of the solution touching the amalgam. As already indicated, the production of nitrous oxide and of nitrogen is at the expense one of the other, not at that of the hyponitrite or hydroxylamine. Similarly, the hyponitrite and hydroxylamine increase each at the expense of the other. Yet it does not seem that the nitrogen is produced by reduction of the nitrous oxide, and certainly the hydroxylamine is not a reduction product of the hyponitrite. It also does not seem that the nitrous oxide comes from the decomposition of the sodium hyponitrite to any important extent.

Sodium nitrite, reduced by sodium amalgam, passes, it would seem, first into the unknown transition products, NaNO and NaON , to the extent of four-fifths into the former and one-fifth into the latter. From the latter, or sodioximide radicle, the hyponitrite will be formed by condensation when the alkali solution is concentrated, and the hydroxylamine by reduction when the alkaline solution is dilute. From the former, or sodium nitroside radicle, the nitrous oxide will be produced by condensation and hydrolysis at low temperatures, or the nitrogen by reduction, condensation, and hydrolysis, at high temperatures.

The reduction of potassium nitrite by potassium amalgam proceeds closely on the same lines as that of sodium nitrite by sodium amalgam.

142. "Hyponitrites; their preparation by sodium or potassium, and properties." By E. Divers.

Sodium nitrite reduced in concentrated solution by sodium amalgam, yields a third of its weight of silver hyponitrite, and nearly the

equivalent amount of several other hyponitrites, without the need of this salt as an intermediary. In this respect, the process has an advantage over the oxyamidosulphonate method. The hydroxylamine, which always accompanies the sodium hyponitrite, is easily got rid of by the continued action of the sodium amalgam, which is without action on the hyponitrite itself. The resulting ammonia is removed by exposure of the solution over sulphuric acid for a night under reduced pressure. Mercuric oxide, employed by all other chemists to remove hydroxylamine, has the fault of regenerating nitrite. The concentrated solution of sodium hyponitrite and hydroxide, thus obtained, is remarkably stable. In the preparation from it of other salts than the sodium salt itself and the silver salt, the sodium hydroxide has first to be neutralised, after diluting the solution with ice and water, mercurous nitrate being employed as an indicator with portions of the solution.

Sodium hyponitrite is prepared from the most concentrated alkaline solution, obtained as above, by precipitation with absolute alcohol, or (Jackson) by evaporation in a vacuum and washing the salt with alcohol. It forms minute, crystalline granules, $(\text{NaON})_2 + 5\text{H}_2\text{O}$, which effloresce and evolve nitrous oxide in the air, but in a vacuum desiccator are converted into an anhydrous non-coherent powder, stable in dry air. The anhydrous salt bears a somewhat high temperature in dry air without decomposition, then fuses and effervesces, forming sodium oxide, sodium nitrite, and nitrogen. According to Prof. Ikeda, sodium hyponitrite gives numbers for its molecular magnitude approximating to those required for $(\text{NaON})_2$ by Lowenherz's cryoscopic method.

Silver hyponitrite is prepared by adding a highly dilute solution of silver sulphate or nitrate to the alkaline solution already described. It decomposes exceedingly slowly in the moist state, forming products similar to those obtained on heating. It is also decomposed by bright light, becoming brown, but is not blackened, by the light alone. When heated, it is decomposed without explosion, its yellow colour changing directly to that of metallic silver, without intermediate darkening; the products are silver, silver nitrate, nitrogen, nitric oxide, and nitric peroxide. A study of the change renders it most probable that the nitric oxide and silver nitrate are not primary products, but arise from interaction between the nitric peroxide and undecomposed hyponitrite. Sodium chloride solution digested with excess of silver hyponitrite has only 25/43 of its chlorine displaced by the hyponitrite ion. Paal's supposed silver nitrito-hyponitrite, $\text{Ag}_2\text{N}_2\text{O}_3$, appears not to exist.

The preparation and properties of mercuric, mercurous, cupric, lead, barium, strontium, calcium, and potassium hyponitrites are described. Cuprous hyponitrite could not be obtained, nor were Rây's basic mer-

curic compounds met with. Maquenne's hypo-isonitroso-acetates were examined, and the formula $\text{OAc} \cdot \text{Ca} \cdot \text{O} \cdot \text{N}_2 \cdot \text{OAc}, \text{Ca}(\text{OAc})_2, 5\text{H}_2\text{O}$ is suggested for the calcium salt.

Hyponitrous acid, in solution, is more acid to litmus paper than carbonic acid, but its effect disappears as the paper dries. It decomposes slowly into nitrous oxide and water (and nothing else except a trace of nitrous acid having another origin). When pure, it has no action on iodine-water or with the starch-iodide test. It decomposes silver carbonate, sulphate, nitrate, and chloride, when present in excess but not the iodide. It is easily oxidised, but is unaffected by reducing agents. Apparently it has not yet been obtained free from every trace of nitrous acid; when carefully prepared, it will remain, however, for more than an hour without producing a blue colour with the starch-iodide test. Hyponitrous acid can be estimated gravimetrically as the silver salt, and volumetrically by potassium permanganate. Thum's permanganate process, in which the hyponitrous acid becomes ultimately nitric acid, is an excellent one; the failure of Hantzsch and Sauer and of Kirschner in its use is due to the modifications they made in it.

DISCUSSION.

Professor DUNSTAN remarked that Dr. Divers in the present series of papers had cleared up a number of doubtful points. In connection with the formation of hyponitrite by the reduction of nitrite in aqueous solution, Dr. Divers had confirmed the observations made in 1887 by Mr. Dymond and himself, as to the simultaneous production of hydroxylamine and its non-formation by the further reduction of hyponitrite. He still adhered to the view that they put forward that these results were best explained by the assumption that the nitrite was first hydrogenated, forming a compound of the formula $\text{NaN}(\text{OH})_2$, which on the one hand loses water, forming hyponitrite, and on the other is hydrolysed, forming sodium hydroxide and dihydroxylamine, $\text{NH}(\text{OH})_2$, which by further reduction furnishes hydroxylamine.

Mr. G. N. HUNTLY pointed out that the hypothesis of the formation of dihydroxylamine, as a first reduction product, suggested by Professor Dunstan had the advantage of being equally applicable to the two other methods of preparing hyponitrites, viz., from sodium hydroxylaminesulphonate (Divers), and benzenesulphohydroxamic acid (Piloty), by the action of concentrated potash. The three reactions on this hypothesis would be represented as follows:—(1) $\text{NH}(\text{OH})(\text{SO}_3\text{Na}) + \text{KOH} = \text{KNaSO}_3 + \text{NH}(\text{OH})_2$; (2) $\text{NH}(\text{OH})(\text{SO}_2 \cdot \text{C}_6\text{H}_5) + \text{KOH} = \text{C}_6\text{H}_5 \cdot \text{SO}_2\text{K} + \text{NH}(\text{OH})_2$; (3) $\text{HO} \cdot \text{NO} + 2\text{H} = \text{NH}(\text{OH})_2$.

In alkaline solution, the dihydroxylamine would condense thus, $\text{OH} \cdot \text{NH} \cdot \text{OH} + \text{H}(\text{OH})\text{N} \cdot \text{OH} = \text{OH} \cdot \text{N} : \text{N} \cdot \text{OH} + \text{H}_2\text{O}$, and there being

no tendency to condensation in acid solution, further reduction should give hydroxylamine, a conclusion in accordance with the facts observed by Professor Divers.

143. "Paranitro-orthanisidine." By Raphael Meldola, F.R.S.

As paranitro-orthanisidine (m. p. 139—140°), which was described in a paper published in conjunction with Messrs. Woolcott and Wray (Trans., 1896, 69, 1330), has recently been made the subject of a patent by the "Fabriques de Produits Chimiques de Thann et de Mulhouse" (Germ. Pat., 98637 of 1897), the author records some further observations which have been made with the substance, as it is proposed to continue its investigation.

The acetyl derivative, purified by repeated crystallisation from water so as to get rid of the isomeric metanitro-derivative simultaneously formed, melts at 153—154°, the melting point 143—146° given in the former paper being that of the mixed isomerides. The acetyl-derivative of *p*-nitro-*o*-anisidine can be reduced by dissolving in hot water and agitating with iron dust and a little acetic acid. The *p*-amido-*o*-acetanisidide thus formed is somewhat unstable, and has not yet been isolated. It is readily diazotisable, and the NH_2 -group has by this means been replaced by iodine with the formation of *p*-iodo-*o*-acetanisidide, $[\text{NHAc}:\text{OMe}:\text{I}=1:2:4]$. This compound crystallises in beautiful, silvery scales melting at 175—176°.

0.1778 gave 7.4 c.c. moist nitrogen at 19° and 764 mm. $\text{N}=4.80$.

0.202 ,, 0.1618 AgI. $\text{I}=43.28$.

The formula requires $\text{N}=4.81$ per cent. ; $\text{I}=43.64$ per cent.

Mr. Frederick Henry Streatfeild was assisting in this investigation, but having left to accept an appointment elsewhere, the work was temporarily interrupted.

CERTIFICATES OF CANDIDATES FOR ELECTION
AT THE NEXT BALLOT.

N.B.—The names of those who sign from “General Knowledge” are printed in *italics*.

The following Candidates will be balloted for on Thursday, December 1, 1898.

Bell, Hugh Poynter,

30, Egerton Crescent, S.W.

Student. B.A. Cambridge, 1894. Studied Chemistry at Kiel and Bonn, 1895—1898.

Henry E. Armstrong.

Sidney Williamson.

Edwin C. Jee.

Gerald T. Moody.

William A. Davis.

William J. Pope.

Berry, Reginald Arthur,

The University Chemical Laboratory, Cambridge.

Private Assistant to Professor Liveing since May, 1895. Associate of the Institute of Chemistry (new regulations). Cambridge University Diploma in Agriculture.

G. D. Liveing.

H. J. H. Fenton.

W. J. Sell.

Thomas H. Easterfield.

T. B. Wood.

Birkett, Walter,

23, Cheviot St., Lincoln.

Head Master of Lincoln Higher Grade School. Lecturer in Chemistry at Lincoln Christ's Hospital Buildings (four years). Lecturer in Agricultural Chemistry as applied to Agriculture at Lincoln Training College (four years). Student of Chemistry (two years) under E. C. Gill, B.A., B.Sc. (Lond.). Desirous of Fellowship for purpose of keeping abreast of recent discoveries in Chemical Science through the medium of the Society's publications.

John Hope Belcher.

Hy. Fairrie.

F. Percy Watson.

Francis Henry Tate.

Hudson Donaldson.

Chas. Bradshaw.

W. H. Stables.

Boardman, Thomas Henry,

4, St. George's Terrace, Wilton, Taunton.

Science Master at Huish School, Taunton. Teaching experience of one year. Second Class Natural Science Honours Degree at Cambridge (Peterhouse), taking Chemistry as one of my subjects.

W. J. Sell.

William French.

H. J. H. Fenton.

James Dewar.

W. T. N. Spivey.

Charles T. Heycock.

Bogert, Marscon Taylor, A.B., Ph.B.,

259, Broadway, Flushing, New York, U.S.A.

Instructor in Organic Chemistry at Columbia University, New York City. Investigations on Sulfoeyamides, Imides, Nitrils, &c. "Carbon Compounds used in Medicine." Lectures and papers showing relation between physiological action and chemical constitution, &c., &c.

H. T. Vulté.

Jas. S. C. Wells.

C. F. Chandler.

Elwyn Waller.

Arthur H. Elliott.

Brooke, Arthur,

17, Cavendish Square, Hull.

Science Master, B.A. (Natural Science Tripos), Cantab., late of St. John's College, Cambridge. First M.B. examination. For five years Science Master, Hull Grammar School. Lecturer in Electricity and Physiology at the Young People's Christian and Literary Institute, Hull.

W. J. Sell.

S. Ruhemann.

H. J. H. Fenton.

W. T. N. Spivey.

C. T. Heycock.

Brünnich, Johannes Christian,

Agricultural College, Gatton, Queensland.

Chemist to the Department of Agriculture, Queensland. Student for three years of the Chemical Faculty of the Polytechnic School in Zürich, 1879—1881. For several years Analyst in Bohemian Sugar Factories. For ten years Chemist and Mill Manager of the Colonial Sugar Refining Company's Sugar Mill at Homebush.

A. Alexander Ramsay.

Thos. Steel.

T. W. Walton.

Jas. Morison.

F. B. Guthrie.

de Castro, John Paul,

Ford House, Redruth, Cornwall.

Principal of and Lecturer in Inorganic Chemistry, Metallurgy, and Mineralogy, at the Redruth School of Mines. 1890—1892, Student

in Laboratory and School of Chemistry, Margate, G. R. Tweedie, F.C.S., Principal. 1892—1895, Student in the Cambridge University Chemical Laboratory. Passed Parts I. and II. of Special Examination in Chemistry for B.A. degree. 1895—1897, worked in the Metallurgical Laboratories of the Royal School of Mines, S.K., and obtained Certificate for passing in final examination in Metallurgy and Assaying.

W. C. Roberts-Austen.

H. J. H. Fenton.

W. J. Sell.

G. D. Liveing.

S. Ruhemann.

Henry C. Jenkins.

F. H. Neville.

Chapman, David Leonard,

Hulme Hall, Plymouth Grove, Manchester.

Demonstrator, Owens College. B.A., Oxford (Final Honours School in Chemistry and Physics) Demonstrator at the Owens College, Manchester, in Chemistry.

H. B. Dixon.

G. H. Bailey.

W. H. Perkin.

E. J. Russell.

D. S. Jordan.

Crouch, William Samuel,

Colombo, Ceylon.

Pharmaceutical Chemist and member of the Pharmaceutical Society of Great Britain. Formerly Student in the Pharmaceutical Society's School of Chemistry. Now Laboratory Manager to the Colombo Apothecaries Company.

Charles Ekin.

Edward F. Harrison.

M. Carteighe.

Walter Hills.

W. Watson Will.

E. J. Millard.

Robert Haselwood Jones.

J. C. Stead.

Ernest Goulding.

Cunnington, Alfred Valentine,

Christ's College, Cambridge.

Scholar of Christ's College. Natural Sciences Tripos, Part I., June, 1897. Natural Sciences Tripos, Part II., June, 1898. Carrying out Research work to Dr. S. Ruhemann.

S. Ruhemann.

R. S. Morrell.

W. A. Shenstone.

A. Hutchinson.

M. M. Pattison Muir.

R. H. Adie.

Davidson, William Brown,

29, Bedford Street, Liverpool.

M.A., B.Sc., Ph.D., Private Research Assistant to Professor J. Campbell Brown. Contributions to Chemical Science:—(1) "Inter-

action of 1 : 2-Diketones with Primary Amines of the General Formula $R' \cdot CH_2 \cdot NH_2$." By F. R. Japp, F.R.S., and W. B. Davidson, M.A., B.Sc., *Trans. Chem. Soc.*, 1894, pp. 32—47. (2) "Condensation of Benzile with Ethylic Malonate." By F. R. Japp and W. B. Davidson. *Trans. Chem. Soc.*, 1895, pp. 132—139. (3) "Ueber Diazophenole." By A. Hantzsch und W. B. Davidson. *Ber.*, 29, 1522—1536. (4) "Physikochemische Untersuchungen über Diazoniumsalze, Diazoniumhydrat und normale Diazotate." By W. B. Davidson und A. Hantzsch, *Ber.*, 31, 1612—1648. (5) "Inaugural Dissertation zur Erlangung der Doctorwürde." Würzburg, February, 1898, pp. 155. Was engaged for a year (1893-94) as Private Research Assistant to Professor Japp, Aberdeen.

J. Campbell Brown.

W. Collingwood Williams.

Charles A. Kohn.

F. R. Japp.

John Harger.

T. S. Murray.

Dickson, Samuel,

The Kraal, Elm Road, New Malden.

Analytical Chemist. I have acted as chief assistant Chemist to Messrs. Stanger and Blount, of Broadway, Westminster, for the last 11 years, and in their laboratory have carried out many technical investigations and analyses of structural materials, waters, soils, clays and metalliferous minerals for the Crown Agents for the Colonies and other Government Departments.

W. Harry Stanger.

W. J. Atkinson Butterfield.

Bertram Blount.

Leonard M. Nash.

H. Wilson Hake.

A. Dupré.

Drake, Francis Alfred,

Rivington and Blackrod Grammar School, Horwich, Lancs.

Teacher of Chemistry. Have taken the degree of Bachelor of Science, London (1895); have been a Teacher of Chemistry for 5 years, and am much interested in the advancement of Chemical Science and Teaching.

Chas. Mills.

Richard Berneastle.

Gerald T. Moody.

A. Lapworth.

William J. Pope.

Arthur Marshall.

Ferguson, James Edward,

26, Connaught Road, Stroud Green, London, N.

Analytical Chemist and Assayer. Student in Chemistry during four sessions, under Prof. Isaac S. Scarf, F.I.C., F.C.S., at the City of London College, White Street, E.C. Hold the following Certificates from H.M. Dept. of Science and Art, viz., 1st class Theoretical In-

organic Chemistry, advanced stage; 1st class Practical Inorganic Chemistry, advanced stage; 1st class Theoretical Metallurgy, advanced stage; and 2nd class Practical Metallurgy, advanced stage. Also two Certificates granted by the Council of the City of London College, viz., 2nd class Theoretical Inorganic Chemistry, and 1st class Practical Inorganic Chemistry. Over 6 years' experience in Analytical Chemistry, as assistant to Mr. Edwd. Riley, F.I.C., F.C.S., of 2, City Road, London, E.C., and 2 years Chief Chemist to the company working the Royal Iron Ore Mines in the Island of Elba, Italy. Presently Analytical Chemist and Assayer to a firm of mineral merchants in London.

Edwd. Riley.

Harold W. Harrie.

William H. Martin.

F. W. Daw.

Isaac S. Scarf.

E. J. Jackman.

Gardner, Edward,

27, Thurlow Road, Hampstead, N.W.

Technical Chemist. I have studied Inorganic and Organic Chemistry for 3 years at the City and Guilds Technical College, Finsbury, and have been engaged for 3 years as Chemist to Messrs. Johnson, Matthey & Co.

George Matthey.

Francis H. Carr.

R. Meldola.

M. O. Forster.

R. C. T. Evans.

Goldsmith, John Naish,

Rock House, Tunbridge Wells.

Chemist to the British Xylonite Co., Manningtree, Essex. Bachelor of Science in Chemistry (Victoria), 1894. Ph.D. Heidelberg, 1898. Dissertation "Über Me·I·Ph-3-Cyclohexenon-5," &c.

H. B. Dixon.

G. H. Bailey.

D. S. Jerdan.

W. A. Bone.

W. H. Perkin.

J. F. Thorpe.

W. T. Lawrence.

Hadley, E. B.,

The Green, Calne, Wilts.

Science Master and Superintendent of Agricultural Experiments to the Wilts County Council. Head Master Calne Technical School. I have lectured on Chemistry for the last 15 years, and conducted classes in Practical Chemistry for the last 12 years. I am in charge of the Agricultural Experimental Stations at Quemerford, Lickhell, and the Sands under the Wilts C.C.

Chapman Jones.

W. Palmer Wynne.

G. S. Newth.

Fredk. Wm. Brown.

A. E. Tutton.

Hartridge, Alfred,

14, Broad Street, Oxford.

B.A. Exeter College, Oxford. 1st Class in Final School of Natural Science (Chem.), 1897. Engaged in teaching and research.

John Conroy.

John Watts.

W. W. Fisher.

J. E. Marsh.

D. H. Nagel.

V. H. Veley.

Haworth, John,

4, Horsdon Terrace, Tiverton, Devon.

Public Analyst and Teacher of Chemistry. Public Analyst to the Borough of Tiverton, and for 9 years Demonstrator of Chemistry in the laboratory of Blundell's School, Tiverton.

Morris W. Travers.

A. H. Mitchell.

Frank Scudder.

William G. White.

H. E. Roscoe.

Hendry, Alexander Garden,

14, Avenell Road, London, W.

Laboratory Manager to Messrs. Lorimer & Co., Manufacturing Chemists, London. Pharmaceutical Chemist, 1st class Advanced Organic Chemistry, 1st class Advanced Inorganic, Heriot Watt College, Edinburgh.

Frederick R. Holloman.

F. Stanley Kipping.

William Duncan.

W. H. Perkin, jun.

Alex. Gunn.

John Fleet.

Peter MacEwan.

Holroyd, George William Fraser,

10, Kensington Garden Terrace, London.

Student of Chemistry. Fell Exhibitioner of Christ Church, Oxford. First class in Chemistry in the School of Natural Science. Has worked for 2 years in Munich under Professor v. Baeyer.

A. Vernon Harcourt.

Frank Clowes.

John Conroy.

D. H. Nagel.

P. Elford.

Howe, Walter,

45, Spring Gardens, Bradford.

Brewer and Chemist. Have attended Courses of Lectures on both Theoretical and Practical Chemistry. Am member of Yorkshire Institute of Brewing, and was on committee from commencement until I resigned last year. Being interested in practice and science of

brewing, am desirous of keeping in touch with the latest developments of the chemistry of the subject.

Alex. K. Miller.

Chas. William Sutton.

Arthur W. Rogers.

Alfred Gordon Salamon.

J. A. Fawcett.

A. Hadley.

Basil P. Wigan.

Hill-Jones, Thomas,

Eagle Wharf Road, London.

Manufacturing Chemist. Succeeded grandfather and father in business of Chemical Manufacturers. Studied Chemistry at Birkbeck Institute, London, and worked in laboratory at the works. Had charge of all departments of manufacture until succeeded father as head of the business.

Frederic H. Bowman.

T. A. Reid.

F. E. Bowman.

Francis Henry Tate.

E. Douzard.

Jordan-Smith, Benjamin,

42, King's Road, Reading.

Science Master in Longton Endowed School, and Instructor in Chemistry to the Longton Corporation's Technical Classes. Associate of the Royal College of Science in Chemistry.

T. E. Thorpe.

Walter Palmer.

W. Palmer Wynne.

Thomas Turner.

A. E. Tutton.

Kay, Reginald Arundale,

7, The Causeway, Cambridge.

Agriculturist. Member of the Royal Agricultural College, by Examination. Student at above in Analytical Chemistry.

Edward Kinch.

John A. Voelcker.

Cecil Cooke Duncan.

T. A. Dickson.

John Stewart Remington.

James Muir.

Mascarenhas, John Charles,

35, Harold Road, Upton Park.

Analytical Chemist, &c. Student of Theoretical and Practical Chemistry for 7 years at City of London College. Holder of 2 Advanced Certificates in Chemistry, and still prosecuting the study of Organic Chemistry. Student of Physics. Engaged in the analysis of minerals, &c. Have a good knowledge of Pharmaceutical Chemistry and Materia Medica.

Isaac S. Scarf.

E. J. Jackman.

Horace V. Buttfield.

Charles A. West.

Vivian B. Leves.

Nightscales, Thomas Arthur,
Tynemouth Street, Hull.

Assistant Laboratory Manager and Analyst for Messrs. Allison, Johnson and Foster, Limited, Hull. Pupil, G. Carr-Robinson, Esq., F.C.S., F.I.C., &c., Hull. Assistant 12 months of Mr. Luxton, Chemist, Hull Municipal Technical Schools. At present engaged in Analytical and Technical work in connection with Pharmacy.

Thomas Tyrer.

Fred. E. Johnson.

Harry Thompson.

G. Carr-Robinson.

H. Irving Foster.

Edward G. Gravill.

Pollard, William,
Hitchin, Herts.

Temp. Assistant Geologist, Geological Survey. "Acidmetrische Bestimmung d. Molybdänsäure" (Sentert and Pollard, *Z. Anorg. Ch.*, 8, 296). "Atomgewicht d. Molybdäns" (Sentert and Pollard, *Z. Anorg. Ch.*, 8, 439). "Note on Lead Tetracetate" (Hutchinson and Pollard, *Trans. Chem. Soc.*, 1893, 63, 1136). "Lead Tetracetate and the Plumbic Salts" (Hutchinson and Pollard, *Trans. Chem. Soc.*, 1896, 69, 212).

M. M. Pattison Muir.

W. T. N. Spivey.

S. Ruhemann.

T. B. Wood.

A. Hutchinson.

R. S. Morrell.

Ray, John Armstedt, jun., B.A.,
15, Nassau Street, Dublin.

Analytical and Pharmaceutical Chemist. Has been a Student in the Dublin University Laboratory for two years, and is engaged in Pharmaceutical practice.

J. Emerson Reynolds.

Emil A. Werner.

G. Percy Bailey.

Chas. R. C. Tichborne.

Harry Carter Draper.

Rich, Edmund Milton,
7, Therapia Road, Honor Oak, S.E.

Science Master. A. C. G. I. Science Master Colfe Grammar School.

Henry E. Armstrong.

William Jackson Pope.

Edwin C. Jee.

William A. Davis.

Thomas Martin Lowry.

Gerald T. Moody.

W. Palmer Wynne.

Rigg, Gilbert,
Tudor Villa, Bryn Road, Swansea.

Chemist and Managing Director. Nine years as student, assistant, and manager in the laboratory of Dr. C. A. Burghardt, Analytical

Chemist, of Manchester. Student of Chemistry and Prizeman in Mineralogy at Owens College, Manchester. Co-patentee with Dr. Burghardt in a process for treating refractory ores of zinc and other metals, and Managing Director of the Manchester Zinc and Copper Co., Ltd. formed to work the same.

Edw. Schunck.

David Watson.

George J. Allen.

Walter Ratcliffe.

J. Carter Bell.

Rofe, Henry John.

8, Powis Square, Bayswater, W.

Civil Engineer. B.A. Balliol College, Oxford, with Honours in Chemistry. Interested in the application of Chemistry to Engineering.

A. Vernon Harcourt.

John Conroy.

D. H. Nagel.

C. J. Baker.

William E. Moss.

Sand, Henry J. S.,

2, Cantlowes Rd., Camden Sq., N.W. (or Tieckstrasse 12, Dresden).

At present engaged in research work at the Chemical Laboratory of University College, London. Studied Chemistry from 1892 to 1894 at the Royal Saxon Polytechnic of Dresden, and afterwards at the Federal Swiss Polytechnic of Zürich till 1896. After that engaged in a research on nitroso-bodies, at Zürich, till the end of 1897, the results of which appeared in my Inaugural thesis. Holder of the Diploma of the Zürich Polytechnic, and of the degree of Doctor of Philosophy of the University of Zürich.

William Ramsay.

Frank Collingridge.

J. Wallace Walker.

A. M. Kellas.

Edward C. Cyril Baly.

Seligman, Richard,

15, Queen's Gate Gardens, London, S.W.

Recently engaged in research at the Central Technical College, and shortly proceeding to work under Professor Curtius, Associate of the City and Guilds of London Institute, after having spent three years in the Chemistry Department of the Central Technical College under Professor Armstrong.

Henry E. Armstrong.

Rudolph Messel.

William A. Davis.

Gerald T. Moody.

Edwin C. Jee.

Sidney Williamson.

Senior, George, B.A. (London),

"Arwendon," Abergele, North Wales.

Certificated Teacher. Science Master of Abergele County School.

Have taught Chemistry in Higher Grade Schools at Rochdale and Nottingham, and also at Aberayron County School, for over 12 years.

Thos. W. Berry.

W. B. Hards.

Wm. A. Knight.

Gerald G. Quinn.

Duncan T. Richards.

Herbert Entwistle.

Smiles, Samuel, jun., B.Sc.,

Fairoak, Beckenham, Kent.

Chemist. Research Student in University College Chemical Laboratory.

William Ramsay.

G. Nevill Huntly.

Morris W. Travers.

A. M. Kellas.

Edward C. Cyril Baly.

Frank Collingridge.

Steuart, Basil,

Broxburn, near Edinburgh.

Chemist. Studied Chemistry under D. R. Steuart, F.I.C., Broxburn, and Prof. Gibson, Heriot Watt College, Edin. Have worked all day in chemical laboratory for last 4 years. Now Assistant Chemist, Broxburn Oil Works.

J. Gibson.

D. R. Steuart.

John E. Mackenzie.

William S. Anderson.

Robert Irvine.

Walton, Ambrose,

"Gledholt," Lower Broughton Road, Broughton.

Chemical Manufacturer. Now proprietor of the firm of Walton, Jackson and Co., "Globe Chemical Works," late "Aqueduct Works," Marple. I have been, for the 3 years ending 1897, manager of A. Walton and Co.'s Chemical Works of Longwood, Milnsbridge, and Manchester. For 2 years Secretary to John McCall and Co., Ltd., Chemical Manufacturers, Manchester. I have studied the theory of Chemistry as applied to my branch of the industry, and am still prosecuting researches in various directions.

Harry Grimshaw.

Hy. Ellison, jun.

C. Sordes Ellis.

George H. Hurst.

H. F. A. Wigley.

Woods, Charles William Tuthill,

St. Kilda, Tudor Road, Upper Norwood, London.

Science Master, Grammar School, Ashby-de-la-Zouch. (Mr. Woods was Senior Scholar of his year in Natural Science at Sidney Sussex College, Cambridge, but was prevented by illness from taking a degree.—F. H. N.)

F. H. Neville.

G. German.

C. T. Heycock.

S. Ruhemann.

M. M. Pattison Muir.

Young, John Henry, B.Sc.,

115, Birmingham Road, Oldbury, Near Birmingham.

Assistant Chemist at Aluminium Co., Ltd., Oldbury, and Teacher of Chemistry at Wednesbury Technical School, 1893-6. Chemical Honours Student at Owens College, Manchester, June, 1896. Obtained degree of B.Sc. in Honours School of Chemistry, September, 1896, and at present Assistant Chemist in Aluminium Co., Ltd., Oldbury, August, 1897, and at present Teacher of Chemistry Wednesbury Technical School.

H. B. Dixon.

A. William Gilbody.

W. H. Perkin, jun.

T. E. Thorpe.

A. Harden.

The following Certificates were authorised by the Council under Bye-law I (3).

Carroll, Charles Robert,

Hyderabad, Deccan, India.

Surgeon and Chemical Analyst to the Government of His Highness the Nizam of Hyderabad. Lecturer on Chemistry in the Hyderabad Medical School. Licentiate in Medicine and Surgery of the University of Madras.

Wyndham R. Dunstan.

Miller, William Lash, B.A., Ph.D.,

Chemical Laboratory, The University of Toronto.

Demonstrator of Chemistry, the University of Toronto, Toronto, Canada. Publications: Dissertation 1890. *Zeit. phys. Chem.*, 1892; *Journal of Phys. Chem.*, 1897. Demonstrator in the University of Toronto since 1891.

William H. Pike.

W. Hodgson Ellis.

Frank T. Shutt.

Wilder, Frederick Louis,

Villa Nova de Lima, Minas Geraes, Brazil.

Analytical Chemist. Six years assistant in Chemical Laboratory, Charterhouse School, Godalming, Surrey, Rev. S. D. Titmas, Master. Chemist to D. C. Griffiths, Esq., Assayer to Bank of England. Chief Chemist to St. John del Rey Mining Co., Brazil. Associate of Institute of Mining and Metallurgy, London. Member Society of Chemical Industry, London.

T. H. Lee.

RESEARCH FUND.

A meeting of the Research Fund Committee will be held in December. Applications for grants, accompanied by full particulars, should be received by the Secretaries not later than December 5th. Forms of application can be obtained from the Assistant-Secretary, Chemical Society, Burlington House, W.

NOTICE TO AUTHORS.

As the *Proceedings* go to press on the Monday after each ordinary Meeting of the Society, the announcement of papers for the next Meeting cannot be made in this publication unless the papers are in the hands of the Secretaries by noon on that day.

At the next meeting, on December 1st, there will be a Ballot for the Election of Fellows, and the following paper will be communicated.

"The oxidation of polyhydric alcohols in presence of . . ." By H. J. H. Fenton, M.A., and H. Jackson, B.A., B.Sc.

PROCEEDINGS
OF THE
CHEMICAL SOCIETY.
EDITED BY THE SECRETARIES.

No. 200.

Session 1898-9.

December 1st, 1898. Professor Dewar, F.R.S., President, in the Chair.

Certificates were read for the first time in favour of Messrs. Samuel William Allworthy, The Manor House, Antrim Road, Belfast; John Frank Blackstraw, Holly Bank, Marton, Chelford, Cheshire; Henry Cort Harold Carpenter, 109 Banbury Road, Oxford; Frank Cope, 30 Leeds Road, Dewsbury; Thomas James Cozens, The Grammar School, Middleton-in-Teesdale, Co. Durham; Samuel Godfrey Hall, 19 Aberdeen Park, Highbury, N.; Thomas Anderson Henry, 37 Chelsea Gardens, S.W.; Thomas Luxton, 4 Cavendish Square, Margaret Street, Hull; James Roberts, jun., 43 Great Western Road, Glasgow; Frederick William Skirrow, Graystongill, Bentham, Lancaster; Charles Emerique Szarasy, 19 Weymouth Street, Portland Place, W.; Thomas Wilson Wormell, 184 Burrage Road, Plumstead, S.E.

A ballot for the election of Fellows was held, and the following were subsequently declared duly elected.

Hugh Poynter Bell, B.A.; Reginald Arthur Berry; Walter Birkett; Thomas Henry Boardman, B.A.; Marston Taylor Bogert, A.B., Ph.B.; Arthur Brooke, B.A.; Johannes Christian Brünnich; John Paul de Castro; Charles Robert Carroll; David Leonard Chapman, B.A.; William Samuel Crouch; Alfred V. Cunningham, B.A.; W. Brown Davidson, M.A., Ph.D.; Samuel Dickson; Francis Alfred Drake, B.Sc.; James Edward Ferguson; Edward Gardner; John Naish Goldsmith, B.Sc., Ph.D.; E. B. Hadley; Alfred Hartridge, B.A.; John Haworth; Alexander Garden Hendry; George W. F. Holroyd, B.A.; Walter Howe; Thomas Hill-Jones; Benjamin Jordan-Smith; Reginald Arundale Kay; John Charles Mascarenhas; William Lash Miller, B.A., Ph.D.; Thomas Arthur Nightscales; William Pollard, B.A., Ph.D.; John Armstedt Ray, jun., B.A.; Edmund Milton Rich;

Gilbert Rigg ; Henry John Rofe, B.A. ; Henry J. S. Sand, Ph.D. ; Richard Seligman ; George Senior, B.A. ; Samuel Smiles, jun., B.Sc. ; Basil Steuart ; Ambrose Walton ; Frederick Louis Wilder ; Charles William Tuthill Woods ; John Henry Young, B.Sc.

The following papers were read :—

**144. "The oxidation of polyhydric alcohols in presence of iron."
By Henry J. Horstman Fenton, M.A., and Henry Jackson, B.A., B.Sc.**

In continuation of the study of the influence of ferrous iron on the oxidation of various hydroxy-compounds, the authors are engaged in investigating the behaviour of various alcohols, and the present communication gives an account of the results which, so far, have been obtained.

The monhydric alcohols (methylic, ethylic, propylic, isopropylic, and amylic), under the conditions employed, give entirely negative results either in presence or absence of iron. But in the case of all the polyhydric alcohols examined (ethylene glycol, glycerol, erythritol, mannitol, dulcitol, and sorbitol) it is found that the presence of ferrous iron exerts a remarkable influence on oxidation by means of hydrogen dioxide. In the absence of iron, practically no change is produced, but, in its presence, very considerable rise of temperature occurs in all cases, and the alcohol is vigorously oxidised.

Ethylene glycol yields glycollic aldehyde, but apparently no glyoxal. With glycerol, the product appears to be glyceraldehyde with little or no dihydroxyacetone. From erythritol, a product yielding erythrosazone is obtained, and mannitol gives mannose. The yields, generally, are remarkably good as compared with those obtained by oxidation with nitric acid, &c., and in this way it is easy to obtain mannose directly from mannitol without first preparing the hydrazone. The authors are attempting to isolate tetrose in a similar way.

As in the case of tartaric acid, it is found that certain of these polyhydric alcohols may be similarly oxidised by atmospheric oxygen in presence of ferrous iron and of sunlight.

145. "The occurrence of hyoscyamine in the *Hyoscyamus muticus* of India." By Wyndham R. Dunstan and Harold Brown.

The authors find that the stem and leaves of the Indian *Hyoscyamus muticus* contain about 0.1 per cent. of hyoscyamine, and that the alkaloid can be extracted in a pure state from this plant more readily than from ordinary henbane. The plant is fairly abundant in the Punjab and Beluchistan, and is likely to prove of value both as a drug, and as a source of hyoscyamine.

DISCUSSION.

Professor DUNSTAN, in reply to Mr. GROVES, Mr. DAVID HOWARD, and Mr. PAGE, said it was possible that age and climate might have some influence in changing the hyoscyamine and forming other mydriatic alkaloids. There was every reason to believe that the physiological action of the drug was principally due to the alkaloid it contains, and not to any other constituent.

Dr. W. H. Perkin, F.R.S., then took the Chair, and the following paper was read:—

146. "The comparative colour of the vapour of iodine in gases at atmospheric pressure and in a vacuum." By James Dewar, LL.D., F.R.S.

Recently, having had occasion to compare iodine with other substances as a means of obtaining vacua in the construction of vessels used for the storage and manipulation of liquid air in low temperature research, some facts about the behaviour of the vapour of iodine have been observed which deserve to be recorded. Pure iodine in the solid state is usually stated to be perfectly opaque to light, but this is not the character of iodine distilled and condensed on a surface of glass at temperatures between -180° and -190° in vacuum test tubes or bulbs by the use of liquid air. Under such conditions, it is easy to get transparent films of iodine of varying grades of thickness showing brilliantly the colours of thin plates by reflection, and to keep them permanently as long as the low temperature is maintained. The first addition of liquid air to the vacuum bulb or test tube containing excess of solid iodine causes instant precipitation of an opaque film, but this can be avoided by cooling the iodine, which has been caused to sublime to the lower part of the outer test tube or bulb, by a preliminary treatment with a little solid carbon dioxide.

In this condition, when the inner surface of the vacuum vessel is cooled with liquid air, the iodine can only deposit from an atmosphere of great tenuity, and when a given thickness of deposit is reached, any increase can be stopped by removing the vessel from the liquid carbon dioxide and placing it in liquid air. In the same way, films of other substances can be deposited which may be useful in the examination of many physical problems. Stas says that pure iodine gives no visible vapour at the ordinary temperature, but this is contrary to the author's experience. Samples of iodine, obtained from cuprous iodide, from iodoform, and from solution of iodine in potassium iodide, and in sufficient quantity to ensure saturation, gave, in half-litre flasks, a visible colour to the atmosphere at the

ordinary temperature. When, however, a similar flask containing the same iodine was exhausted of air, the colour of the atmosphere was markedly less, and this distinction remained even when the flasks were heated side by side in a water bath. If the iodine vapour diffused into an atmosphere of carbon dioxide, hydrogen, or oxygen, in similar flasks, instead of into air, the colour remained the same; but in all cases it was much more marked than in one from which the gaseous atmosphere, other than iodine, had been in great part removed by the air pump. No change in the mode of filling the air and vacuum flasks made the difference in colour disappear, although a dozen flasks have been filled from time to time. No change in the character of the results was effected by subliming the iodine from anhydrous baryta and keeping it in flasks for months with excess of the latter, nor was any apparent difference produced when the flasks containing the baryta were repeatedly heated at the boiling point of water. This seems to prove that neither water vapour nor hydrogen iodide has anything to do with the cause of the difference in colour of the iodine vapour in the air and vacuum flasks. It is not necessary to use flasks, as two lengths of glass tubing, an inch or less in diameter and a foot or more in length, when heated side by side in a steam or water bath, show the difference of colour.

To obtain an approximate value of the tension of the saturated vapour of iodine at about the ordinary temperature, a Rankine formula of two terms was calculated, taking the known pressure at 58.1° as 4.9 mm. and that at 113.8° as 87 mm. These gave:—(1) $\log P = 9.3635 - \frac{2872}{T}$ mm. If, however, the tension at 85° and

114.1° are selected for calculation, (2) $\log P = 10.0392 - \frac{3137}{T}$ mm., where

T is the absolute temperature. From formula (1) the tensions in mm. of mercury at 0° and 11° are respectively 0.07 and 0.18. The weight of iodine in a litre would thus become about 1 and 1.94 milligrams at 0° and 11° respectively. In order to check this calculation, the quantity of iodine required to saturate a litre of dry air at 0° and 11° was determined by passing a slow current of air over a column of the substance and subsequently absorbing the iodine from the saturated air by passing it through a caustic potash solution. The alkaline solution, after acidifying, was titrated with sodium thiosulphate. The results of the experiments were as follows:—

	Milligrams per litre.	Pressure in mm. of mercury.
0°	0.24	0.017
11°	1.25	0.087
30°	4.70	0.358

In each case, the calculated tension is less than that deduced from the first vapour pressure equation. The values approach those given by Arctowski (*Zeit. Anorg. Chem.*, 1896, 12, 427) as a deduction from his experiments on the volatilisation of iodine. From this, it would follow that the second equation for the tension is the better. In the liquid state, the tensions are well represented by $(3) \log P = 7.924 \frac{2316}{T}$ mm.

From formula (2), the molecular latent heat of solid iodine is 14430 units, and for the liquid condition from (3) the value is 10653. The experimental value of the latent heat of liquid iodine given by Favre is 6000 units. From this, it would follow that the latent heat of volatilisation requires to be redetermined. It is interesting to observe that the number of heat units required to dissociate the molecule of iodine is 28500, or roughly, twice the calculated latent heat of the solid.

The various experiments recorded lead to the conclusion that the phenomenon is a real one, although some factor that has been neglected may explain it; at any rate, it is difficult to avoid getting the result. Assuming it to be true, its explanation then remains to be considered. It is well known that the vapour pressure in a vacuum is often greater than in air at atmospheric pressure. On the other hand, Professor J. J. Thomson, in his work entitled *Application of Dynamics to Physics and Chemistry*, p. 169, discusses this very question. He shows that the effect of the pressure of an inert gas must be to raise the vapour pressure of a substance diffusing into it above that produced by the diffusion of the same substance into a vacuous space. Taking the equation which he there developed as being applicable to iodine, the difference between the two conditions of pressure should amount to $\frac{1}{4 \frac{1}{3} 0}$ of the whole. Now the question arises whether this amount is sufficient to explain the difference of colour or whether it is necessary to bring in other factors which may operate, such as solution of solids in gases under pressure, dissociation, or want of equilibrium. Further experiments will be required before a definite answer can be given.

Hannay and Hogarth first showed that alcohol vapour above its critical point, and therefore at a pressure above 60 atmospheres, can dissolve solids like potassium bromide or iodide, and Cailletet, a little later, found that liquid carbon dioxide was dissolved by air under high compression. Dr. Villard has recently made a series of experiments on the same subject, in which he proves that bromine and iodine dissolve in air or oxygen under high compression. He says: "L'iode se dissout également en quantité sensible dans l'oxygène, mais le phénomène n'est bien visible qu'à partir de 100 atmosphères et dans des tubes de 5 millimetres de diametre au moins."

The experiment exhibited would appear to show that the pressure of one atmosphere is sufficient to produce a sensible difference of colour in the case of iodine vapour diffused in air and in a vacuum. For the present, it may be regarded as a lecture illustration of the rapidity of volatilising iodine in an air space as contrasted with a vacuous one.

DISCUSSION.

Dr. THORPE thought that the phenomenon which the President had brought to the notice of the meeting was highly interesting and suggestive. It seemed to him, after watching the experiment shown to them during its whole course, that the character of the colour of the resulting vapours was so markedly different as to lead to the inference that something more than a mere dilution of colour due to an actual difference in the amount of vapour present had occurred. He could not help comparing the phenomenon with the well-known difference in colour of various solutions of iodine in alcohol, carbon disulphide, chloroform, &c., and thinking that molecular dissociation was taking place. Perhaps in this connection it might be worth while to make a comparative spectroscopic study of the vapours in the two conditions.

Professor F. D. BROWN said that he, too, had remarked the much browner colour of the iodine vapour in the vacuous tube. Remembering the fact that iodine in brown solutions is in a different molecular condition from that in violet solutions, it seemed probable that the vapours in the two tubes were also in different molecular conditions.

With regard to the suggestion that the iodine was in some way dissolved in the gas, he stated that one of his students in New Zealand had ascertained that equal volumes of different gases at the same temperature and pressure took up exactly equal quantities of iodine, whereas it was probable that if iodine dissolved in a gas as a solid dissolves in a liquid differences in solubility would have been found.

Mr. ELWORTHY, in reference to the solubility of solids in gases at temperatures above their critical points, and under pressure, said that when in Bombay he gave instructions for some vulcanised rubber to be placed in a vessel with carbon dioxide at about 5 or 6 atmospheres pressure; instead of this, about 5 pounds of the gas were introduced into a vessel usually employed to contain 15 pounds of liquefied carbon dioxide. At temperatures below the critical point a certain amount of liquefied gas would have been present, but as the temperature was between 87° and 90° F., the gas was in the condition of a vapour under pressure. On opening the vessel and allowing the gas to escape, it was found that practically all the sulphur had been dissolved out of the

rubber, the surface of which was covered with a thin crust of sulphur crystals.

Mr. L. M. JONES asked whether any attempt had been made to determine the actual concentration of the iodine in the two cases ; and also whether the apparent solubility of a solid in gas at high pressure might not be actually due to the increase of vapour pressure predicted by Professor J. J. Thomson.

Dr. TRAVERS pointed out that the critical phenomena observed when the air confined over liquid carbon dioxide was compressed at constant temperature could not be produced by conditions similar to those which were present in the case of the iodine and air. When air was compressed in contact with any liquid, it dissolved and produced a mixture of constantly decreasing critical temperature. Consequently, supposing that sufficient air were present, it should in any case be possible by exerting sufficient pressure to produce a mixture whose critical temperature was the temperature of the experiment. The phenomenon could have nothing to do with the solution of the solid or liquid in the gas.

Dr. FORSTER inquired whether iodine had been imprisoned in atmospheres other than a mixture of nitrogen and oxygen. If, as was suggested, the phenomenon in question is a case of solution, differences in appearance similar to that subsisting between solutions of iodine in alcohol and in carbon disulphide, might be expected in tubes containing iodine enclosed with various inert gases.

The PRESIDENT, in reply, said that the spectroscope had not been used in his experiments, and bearing in mind the character of the absorption spectrum of iodine, he anticipated it would be difficult to obtain any information as to the character of the phenomenon by its employment. The possibility of dissociation had not escaped attention, having been mentioned in the paper. All that he could say was that at present he could not specifically state that the difference in the behaviour of iodine under the two conditions was due to one or other of the possible causes to which he had referred. Iodine enclosed in tubes containing gases such as carbon dioxide, nitrogen, hydrogen, and oxygen gave appearances indistinguishable from those observed in similar tubes containing air.

NOTICE TO AUTHORS.

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At the next meeting, on Thursday, December 15th, the following papers will be communicated:—

“The interaction of ethylic sodiomalonate and mesityl oxide.” By Arthur W. Crossley, Ph.D.

“Derivatives of camphoric acid, Part III.” By F. Stanley Kipping, D.Sc., F.R.S.

“Synthesis of $\alpha\beta\beta$ -trimethylglutaric acid.” By W. H. Perkin, jun., and J. F. Thorpe.

PROCEEDINGS
OF THE
CHEMICAL SOCIETY.
EDITED BY THE SECRETARIES.

No. 201.

Session 1898-9.

December 15th, 1898. Professor Dewar, F.R.S., President, in the Chair.

Mr. H. P. Bell was formally admitted a Fellow of the Society.

Certificates were read for the first time in favour of Messrs. Stuart Blofeld, 4, Camden Gardens, West Kensington Park, W.; Bertram H. Bowles, 53, Dunsmure Road, Stamford Hill, N.; Thomas John Cheater, 6, Boutflower Road, Wandsworth Common, S.W.; George Ward Hedley, 2, St. Luke's Villas, Cheltenham; Harold Octavius Knight, Westfield Villa, Barton-on-Humber; Dudley Northall-Laurie, 56A, Pall Mall, S.W.; James McCracken, 580, Govan Road, Govan, N.B.; John O'Sullivan, 742, Nicola Street, Vancouver City, B.C.; Arthur Lee White, 29, Huron Road, Upper Tooting, S.W.

The following papers were read :—

147. "The interaction of ethylic sodiomalonate and mesityl oxide."
By Arthur W. Crossley.

Attempts to prepare dihydrocamphoric acid synthetically have so far proved unsuccessful (*Trans.*, 1898, 73, 23). Isobutylene dibromide does not condense with ethylic sodiomethylmalonate, nor mesityl oxide with ethylic sodiomalonate, in the expected manner. The thick, oily product obtained in the latter case cannot be distilled in a vacuum without partial decomposition; when hydrolysed with alcoholic potash, it yields a dibasic *acid*, $C_{16}H_{24}O_4$, which crystallises from acetone in colourless, transparent, lustrous prisms belonging to the monosymmetric system, and melts at 148—148.5°, the upper part of the capillary tube becoming covered with a red film. The *ethylic* salt separates from light petroleum in thick, transparent, lustrous prisms, which usually are twinned and apparently belong to the monosymmetric system. It melts at 59.5—60°, boils at 252° in air without

decomposition, and, on hydrolysis, yields the original acid. The *silver* salt crystallises from water in feathery needles.

Sodium amalgam is without action on the acid. Bromine readily converts it into a *dibromo*-derivative, $C_{16}H_{24}O_4Br_2$ or $C_{16}H_{22}O_4Br_2$, which crystallises from dilute alcohol in colourless, glistening leaflets containing $2H_2O$, and melts with slight decomposition at 171° . On treatment with hydrogen bromide, a *dihydrobromide*, $C_{16}H_{26}O_4Br_2$, is obtained, which crystallises in transparent prisms, melts at 169° with decomposition, and is reconverted into the acid, $C_{16}H_{24}O_4$, by interaction with alcoholic potash.

The acid is readily oxidised by alkaline potassium permanganate in the cold, and when the product is treated with chromic acid, an acid melting at 89° is obtained. It is hoped that a study of its oxidation products will give some clue to the constitution of the substance.

148. "The interaction of ethylic malonate and acetylene tetrabromide in presence of sodium ethoxide." By Arthur W. Crossley.

This investigation was undertaken in the hope that ethylic disodium malonate and acetylene tetrabromide would interact according to the equation, $C_2H_2Br_4 + 2Na_2C(CO_2Et)_2 = (CO_2Et)_2C:CH:CH:C(CO_2Et)_2 + 4NaBr$, as the product, on hydrolysis and subsequent heating, should yield muconic acid, $CO_2H \cdot CH:CH \cdot CH:CH \cdot CO_2H$, from which tetrabromadipic acid could be prepared for the purpose of investigating its behaviour with weak alkalis.

The reaction does not take place as expected, and is of a complicated nature, the two main products being tribromomethylene, $CHBr:CBBr_2$, and tetr ethylic acetylenetetracarboxylate; during its progress acetylene is given off, and tarry products are also formed from which no definite chemical compound could be isolated.

The acetylene tetrabromide used was prepared from acetylene generated from calcium carbide by the action of water, and purified by Willgerodt's method (*Ber.*, 1895, **28**, 2108). It boiled at 151° under 54 mm. pressure, and was a clear, colourless, highly refractive liquid.

0.1548 gave 0.3353 AgBr. $Br = 92.18$.

$C_2H_2Br_4$ requires $Br = 92.48$ per cent.

Acetylene tetrabromide (1 mol.) was added to a mixture of sodium (2 mols.) dissolved in absolute alcohol and ethylic malonate (2 mols.), and after the violent reaction had somewhat moderated, the whole was heated on a water bath for $1\frac{1}{2}$ hours. Water was added to the resulting dark, reddish-green, feebly-acid product, and the whole extracted with ether. On washing the ethereal extract with water,

the greater portion of the red colouring matter (from which the tarry products alluded to were obtained) was removed, and also a small quantity of a green solid containing sodium and organic matter. When boiled with acids, this green substance partially dissolved, forming a red solution, which was again turned green by addition of an alkali; but the amount was too small for investigation. On distilling the residue from the dried ethereal extract, fractions were obtained boiling at 65—80° and at 225—230° under 47 mm. pressure; and not more than 0.5 c.c. passed over between these limits.

The fraction boiling at 65—80° under 47 mm. pressure contained tribromethylene, $\text{CHBr}:\text{CBr}_2$. This clear, colourless, heavy liquid, amounting to 63 per cent. of the total ethereal extract, was repeatedly fractionated at the ordinary pressure, and nearly the whole passed over between 164—166°; the residue, when heated above this temperature, gave off bromine and hydrogen bromide, and consisted probably of some unchanged acetylene tetrabromide. On analysis the fraction boiling at 164—166° gave the following numbers.

0.3410 gave 0.7251 AgBr. $\text{Br} = 90.47$.

$\text{CHBr}:\text{CBr}_2$ requires $\text{Br} = 90.56$ per cent.

The substance was further characterised by converting it into pentabromethane by the direct addition of bromine. The resulting solid crystallised from alcohol in long, white, glistening needles melting at 55—55.5°.

0.2656 gave 0.5887 AgBr. $\text{Br} = 94.31$.

$\text{CHBr}_2 \cdot \text{CBr}_3$ requires $\text{Br} = 94.11$ per cent.

The fraction boiling at 225—230° under 47 mm. pressure contained tetrethylic acetylenetetracarboxylate. This fraction solidified almost completely. It was spread on a porous plate, and then purified by recrystallisation from light petroleum boiling at 60—80°, from which it separated in long, white, silken needles melting at 75—76°.

0.1518 gave 0.2936 CO_2 and 0.0940 H_2O . $\text{C} = 52.76$; $\text{H} = 6.87$.

$(\text{CO}_2\text{Et})_2\text{CH} \cdot \text{CH}(\text{CO}_2\text{Et})_2$ requires $\text{C} = 52.83$, $\text{H} = 6.91$ per cent.

Although the conditions under which the reaction was carried out were varied to some extent, the same results were always obtained.

149. "Derivatives of camphoric acid. Part III." By F. Stanley Kipping, D.Sc., F.R.S.

This paper contains an account of the preparation, properties, and transformations of a number of compounds which have been obtained from π -bromocamphoric acid, and is a continuation of previous work (*Trans.*, 1896, 69, 913; Kipping and Pope, *Trans.*, 1897, 71, 963).

πw -Dibromocamphoric acid, πw -dibromocamphoric anhydride and π -bromocamphanic acid have been already briefly described (*Proc.*, 1895, 11, 211).

$w\pi$ -Chlorobromocamphoric anhydride, $C_8H_{12}ClBr\begin{smallmatrix} \diagup CO \\ \diagdown CO \end{smallmatrix} O$, is obtained by treating π -bromocamphoric acid with phosphorus pentachloride, and then passing chlorine into the product heated at 100° . It crystallises in large, orthorhombic prisms melting at $214\text{--}215^\circ$, and resembles the corresponding dibromo-compound in ordinary properties.

$w\pi$ -Chlorobromocamphoric acid, $C_8H_{12}ClBr(CO_2H)_2$, can be prepared by heating its anhydride with concentrated nitric acid; it is a colourless, crystalline compound melting at about 197° , and is very like the dibromo-acid in all respects.

When $w\pi$ -chlorobromocamphoric anhydride is boiled with dilute acetic acid, it is converted into a π -bromocamphanic acid, identical with the compound melting at $176\text{--}177^\circ$, obtained by the decomposition of πw -dibromocamphoric anhydride.

Methylic π -bromocamphanate, $CO_2Me \cdot C_8H_{12}Br\begin{smallmatrix} \diagup CO \\ \diagdown O \end{smallmatrix}$, is easily obtained from the corresponding acid by the ordinary methods; it crystallises in orthorhombic prisms, melts at $87\text{--}88^\circ$, and dissolves freely in most of the ordinary organic solvents.

π -Bromocamphanamide, $NH_2 \cdot CO \cdot C_8H_{12}Br\begin{smallmatrix} \diagup CO \\ \diagdown O \end{smallmatrix}$, is produced when πw -dibromocamphoric anhydride is left in contact with aqueous ammonia, and can also be prepared from methylic π -bromocamphanate in a similar manner; it crystallises in transparent needles melting at $161\text{--}162^\circ$.

The action of alkalis on πw -dibromocamphoric anhydride results in the formation of hydroxy-*cis*- π -camphanic acid (*Trans.*, 1896, 69, 913), but when the anhydride is heated with an aqueous solution of silver nitrate, it is partly converted into the γ -lactone of hydroxycamphotricarboxylic acid (*loc. cit.*); the last-named compound is also formed when π -bromocamphanic acid is boiled with an aqueous solution of silver nitrate.

150. "Synthesis of $\alpha\beta\beta$ -trimethylglutaric acid." By W. H. Perkin, jun., and J. F. Thorpe.

This acid, which is especially interesting on account of the fact that Balbiano (*Ber.*, 1895, 28, 2161) obtained it by simple reactions from camphoric acid, may be prepared synthetically in the following way.

Ethyl cyanacetate is digested in alcoholic solution with sodium ethylate and ethyl dimethylacrylate, and the product,

which contains the sodium compound of *ethylic α-cyano-ββ-dimethylglutarate*, $\text{CO}_2\text{Et}(\text{CN})\text{CNa}\cdot\text{CMe}_2\cdot\text{CH}_2\cdot\text{CO}_2\text{Et}$, is treated with methylic iodide. The resulting *ethylic α-cyano-αββ-trimethylglutarate*, $\text{CO}_2\text{Et}(\text{CN})\text{CMe}\cdot\text{CMe}_2\cdot\text{CH}_2\cdot\text{CO}_2\text{Et}$, a colourless oil boiling at 181° under 25 mm. pressure, yields on hydrolysis *αββ-trimethylglutarimide*, $\text{CMe}_2\left\langle\begin{array}{c}\text{CH}_2-\text{CO} \\ \text{CHMe}\cdot\text{CO}\end{array}\right\rangle\text{NH}$, which crystallises in long needles and melts at 126° .

αββ-Trimethylglutaric acid, $\text{CO}_2\text{H}\cdot\text{CHMe}\cdot\text{CMe}_2\cdot\text{CH}_2\cdot\text{CO}_2\text{H}$, is obtained from this imide by heating with hydrochloric acid at 200° ; it melts at 88° , gives an *anhydride* melting at 82° , and an *anilic acid* melting at 150° , and is, in all its properties, identical with the acid obtained from camphoric acid by Balbiano.

151. "Hydrolysis of methylic and ethylic γ-cyanoacetoacetates and their derivatives. Part I." By W. Trevor Lawrence.

A preliminary account is given of the results obtained in an investigation which had for its primary object the preparation of unsymmetrically disubstituted ethylic acetonedicarboxylates, but has led to the discovery of a new series of acids.

Methylic γ-cyanodimethylacetoacetate, $\text{CN}\cdot\text{CH}_2\cdot\text{CO}\cdot\text{CMe}_2\cdot\text{CO}_2\text{Me}$, is the chief product of the interaction of methylic γ-bromodimethylacetoacetate with potassium cyanide in ethereal solution. It boils at $126-128^\circ$ under 18 mm. pressure. On treatment in ethylic alcohol solution with dry hydrogen chloride, it yields an oil, $\text{CO}_2\text{Et}\cdot\text{CHCl}\cdot\text{CO}\cdot\text{CMe}_2\cdot\text{CO}_2\text{Et}$, which boils at $146-150^\circ$ under 40 mm. pressure, and when hydrolysed with concentrated hydrochloric acid is converted into *αα-dimethyl-β-hydroxyglutaconic acid*. Sodium amalgam does not reduce the nitrile under the varied conditions employed, but converts it into dimethylmalonic acid.

Methylic γ-cyanodimethylacetoacetate is hydrolysed rapidly by concentrated hydrochloric acid, and converted quantitatively into a substance which is regarded provisionally as *αα-dimethyl-β-hydroxyglutaconic acid*, $\text{CO}_2\text{H}\cdot\text{CH}\cdot\text{C}(\text{OH})\cdot\text{CMe}_2\cdot\text{CO}_2\text{H}$, although several of its reactions are difficult to explain if the formula adopted is correct. Thus, the compound remains unchanged on boiling with sulphuric and with nitric acids, is not affected by potassium permanganate at 60° , and gives no coloration with ferric chloride. The acid crystallises from water in prisms, melts at 214° , and distils at 245° . The *hydrogen silver* salt, $\text{C}_7\text{H}_9\text{O}_5\text{Ag}$, and the corresponding *copper* and *zinc* salts have been obtained. The *aniline* salt melts at 122° . The *dimethylic* salt, $\text{CO}_2\text{Me}\cdot\text{CH}\cdot\text{C}(\text{OH})\cdot\text{CMe}_2\cdot\text{CO}_2\text{Me}$, crystallises in needles, melts at 104° , and boils at 285° . The *acetyl* derivative melts

at 136° , and the *benzoyl* derivative at 208° . When the acid is treated with phosphorus pentabromide and the product poured into methylic alcohol, the methylic salt of a bromo-derivative is obtained which, on hydrolysis with hydrobromic acid, yields *aa*-dimethylglutaconic acid.

aa-Dimethylglutaconic acid, $\text{CO}_2\text{H}\cdot\text{CH}:\text{CH}\cdot\text{CMe}_2\cdot\text{CO}_2\text{H}$, is also obtained by the reduction of dimethylhydroxyglutaconic acid with hydriodic acid at 130° in sealed tubes. It crystallises from water in prisms, melts at 148° , and is not reduced by sodium amalgam in the cold.

The following compounds have also been prepared:—*Ethylic γ -bromo-methylethylacetoacetate*, $\text{CH}_2\text{Br}\cdot\text{CO}\cdot\text{CMeEt}\cdot\text{CO}_2\text{Et}$, boiling at 164° under 75 mm. pressure; *ethylic γ -cyanomethylethylacetoacetate*, $\text{CN}\cdot\text{CH}_2\cdot\text{CO}\cdot\text{CMeEt}\cdot\text{CO}_2\text{Et}$, boiling at 158° under 35 mm.; *aa-methyl-ethyl- β -hydroxyglutaconic acid*, $\text{CO}_2\text{H}\cdot\text{CH}:\text{C}(\text{OH})\cdot\text{CMeEt}\cdot\text{CO}_2\text{H}$, melting at 164° ; *ethylic γ -bromodiethylacetoacetate*, $\text{CH}_2\text{Br}\cdot\text{CO}\cdot\text{CEt}_2\cdot\text{CO}_2\text{Et}$, boiling at 180° under 100 mm. pressure; *ethylic γ -cyanodiethylacetoacetate*, $\text{CN}\cdot\text{CH}_2\cdot\text{CO}\cdot\text{CEt}_2\cdot\text{CO}_2\text{Et}$, boiling at 158° under 75 mm. pressure; *aa-diethyl- β -hydroxyglutaconic acid*, $\text{CO}_2\text{H}\cdot\text{CH}:\text{C}(\text{OH})\cdot\text{CEt}_2\cdot\text{CO}_2\text{H}$, melting at 159° .

Different results are obtained by the hydrolysis of these nitriles by means of sulphuric acid and of methyl alcoholic potash; moreover, the products of the reduction of the hydroxyglutaconic acids with hydriodic acid differ with the conditions; the author is engaged in investigating these reactions, as well as the behaviour of the γ -nitriles of ethylic acetoacetate and its derivatives generally.

ADDITIONS TO THE LIBRARY.

I. Donations.

Fresenius, H. Geschichte des chemischen Laboratoriums zu Wiesbaden während der zweiten 25 Jahre seines Bestehens. 4to. Pp. xx + 128, with a frontispiece and 2 plans, 1.p. Wiesbaden 1898.

From the Author.

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II. *By Purchase.*

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— On the "Stringybark" Trees of N.S. Wales, especially in regard to their Essential Oils. Part I. (Read before the Royal Society of N.S. Wales, July, 1898.)

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Fairley, Thomas. On the Water Supplies of Yorkshire. (Reprinted from the *Journal of the Fed. Inst. of Brewing*, 1898.)

Fischer, F. Chemische Technologie an den Universitäten und technischen Hochschulen Deutschlands. 8vo. Pp. 54. Braunschweig 1898.

Fresenius, H. Zur Erinnerung an R. Fresenius. 8vo. Pp. xviii. With a Portrait. Wiesbaden 1897.

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Spring, W. Sur la cause de l'absence de coloration de certaines eaux limpides naturelles. Bruxelles 1898.

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As the *Proceedings* go to press on the Monday after each ordinary Meeting of the Society, the announcement of papers for the next Meeting cannot be made in this publication unless the papers are in the hands of the Secretaries by noon on that day.

At the next meeting, on Thursday, January 19th, the following papers will be communicated.

"Researches on moorland waters. I. Acidity." By W. Ackroyd.

" α -Ketotetrahydronaphthalene." By F. Stanley Kipping, D.Sc., F.R.S., and Alfred Hill.

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Dec. 3, 1891		Baly, Edward C. Cyril, University College, W.C.
Mar. 4, 1886		Bamber, H. K. G., c/o Messrs. Knight, Bevan, and Sturge, Northfleet
Dec. 4, 1890		Bamber, M. Kelway, 9, Victoria-street, S.W.
Dec. 3, 1896		Banerjee, Gopal Ch., Kaiser Soap Co., Cawnpore, India

Date of Election.

Feb. 2, 1888		Banner, Samuel, Sherwood, Sefton-park, Liverpool
Jan. 19, 1871		Bannister, Richard, 59, Tregunter-road, S. Kensington, S.W.
Dec. 2, 1880		Barclay, Arthur E., 95, Farrington-street, E.C.
Mar. 4, 1897		Barclay, John, B.Sc., Avenue Cottage, near Bromsgrove, Worcestershire
Feb. 15, 1877		Bardsley, J., F.I.C., Church Works, Church, Lancashire
Feb. 20, 1896		Barker, W. H., B.Sc., Glen Albyn Villa, Bridgend, South Wales
Dec. 1, 1870		Barklie, Robert, Linden Lodge, Jordantown, Belfast
Dec. 6, 1894		Barlet, Stéphane, B.Sc., 47, Bassett-road, N. Kensington, W
May 6, 1897		Barlow, H. W. L., M.A., M.B., Oxon, Holly Bank, Urmston, Manchester
June 17, 1897		Barlow, W. H., 152, Osbaldestone-road, Stoke Newington, N.
May 6, 1897		Barlow, William, Hillfield, Muswell Hill, N.
May 7, 1891		Barnes, Edward Arthur, 194, Hammersmith-road, W., and Dynamite Works, Zuurfontein, S.A.R.
Dec. 2, 1875		Barnes, R. L., Phœnix Chemical Works, Hackney Wick, N.E.
Feb. 21, 1884		Barr, William Henry, M.D., Belgrave-place, Bury
Feb. 16, 1888		Barraclough, William H., F.I.C., Mortomley, near Sheffield
May 16, 1895		Barralet, E. S., 88, King Edward's-road, S. Hackney, N.E.
Dec. 3, 1891		Barratt, J. Treeby, Bronheulog, Mostyn, North Wales
Feb. 4, 1869		Barret, Edward L., B.Sc., 8, Rue Voltaire, St. Germain en Laye, Seine et Oise, France
Feb. 5, 1874		Barrett, Howard, M.R.C.S., M.R.C.P., 49, Gordon-square, W.C.
June 16, 1892	Trans.	Barrows, Arthur Edward, Bloomfield Iron Works, Tipton, Staffordshire
Jan. 18, 1872		Barton, Robert, Royal Mint, Melbourne, Australia
April 19, 1883		Basker, J. A., Fore-street, Bridgwater
April 21, 1898		Baskerville, Charles, B.Sc., Ph.D., University of North Carolina, Chapel Hill, N.C.
Mar. 4, 1897		Bastow, Frank, Braithwaite, Keighley, Yorks
Feb. 18, 1864	Trans.	Bassett, Henry, 26, Belitha-villas, Barnsbury, N.
May 7, 1891		Bate, William, National Explosives Co., Hayle, Cornwall
June 15, 1893		Bateman, John, Messrs. J. C. and J. Field, The Marsh, Lambeth, S.E.
May 7, 1891		Bater, Claude H., M.A., Inland Revenue, 120, Loughborough-road, West Bridgford, Nottingham
Dec. 3, 1896		Bathurst, Charles, jun., B.A., 3, Stone-buildings, Lincoln's Inn, W.C.
Dec. 3, 1896		Bay, L. H., The Grammar School, Carlisle
June 16, 1892		Bayliss, Charles, Ellesmere, Selly Park, near Birmingham
Nov. 19, 1874		Bayly, F. W., The Royal Mint, E.
June 4, 1874		Bayne, James, Professor, Royal Veterinary College, Camden Town, N.W.
June 19, 1879		Bayne, William Thirlwall, LL.D., Brockhill, Broad Clyst, Exeter

Date of Election.

Dec. 4, 1873		Baynes, James, Ph.D., F.R.M.S., Borough Analyst's Office, Royal Chambers, Scale-lane, Hull
Dec. 2, 1897		Beadle, A. A., Beadonwell, Belvedere, Kent
Feb 19, 1891	Trans.	Beadle, Clayton, The Rookery, Belvidere, Kent
Feb. 7, 1861		Beadnell, Major Charles Edward, R.A., Fernside, Redhill, Surrey
Dec. 5, 1867		Beale, William Phipson, Q.C., 10, New-court, Carey-street, Lincoln's-inn, W.C.; and 19, Upper Phillimore-gardens, Kensington, W.
Mar. 3, 1864		Beanes, Edward, Moatlands, Paddock Wood, Kent
Mar. 6, 1890		Beardmore, G. Russell, D.P.H. Camb., L.R.C.P. Lond., M.R.C.S. Eng., L.S.A., Warwick House, Upper-street, Islington, N.
April 21, 1887		Beasley, William C. T., B.A., Fermain, St. Leonards-on-Sea
April 17, 1890	Trans.	Beck, Charles R., 118, Disraeli-road, Putney, S.W.
April 2, 1874	Trans.	Beckett, George Henry, Wolston, near Coventry
May 4, 1882		Beckett, John Hampden, Corbar Hill House, Buxton, Derbyshire
Feb. 6, 1879	Trans.	Bedson, P. Phillips, D.Sc., M.A., University College, Newcastle-on-Tyne
Dec. 19, 1872	Trans.	Beilby, George T., St. Kitts, Slateford, N.B.
June 18, 1891		Belbin, T. St. J., 101, Piccadilly, W.
Dec. 6, 1888		Belcher, John Hope, B.A., Technical Institute, Coventry
May 7, 1891		Bell, Albert Edward, F.I.C., 2, Ellington-villas, Sherborne, Dorset
Dec. 2, 1886	Trans.	Bell, Chichester A., B.A., M.B. (Dublin), 3, Mansfield-place, Richmond, Surrey
June 20, 1889		Beli, E. Wightman, Spalding
Jan. 19, 1865	Trans.	Bell, J. Carter, the Cliff, Higher Broughton, Manchester
Dec. 3, 1863	Trans.	Bell, Sir Lowthian, Bart., F.R.S., Rounton Grange, Northallerton
Jan. 17, 1889		Bell, Percy Carter, 150, Nassau-street, New York, U.S.A.
Dec. 4, 1879		Bemrose, Joseph, 56, St. Famille-street, Montreal, Canada
Dec. 17, 1874		Bendix, David, Sutherland Lodge, 371, Romford-road, Forest Gate, E.
Nov. 19, 1874		Benger, Frederick Baden, F.I.C., The Grange, Knutsford, Cheshire
Feb. 17, 1881		Benjamin, Marcus, M.A., Ph.D., Smithsonian Institution, Washington, D.C., U.S.A.
April 15, 1886		Bennert, Carl, Ph.D., Godesberg, Germany
Dec. 15, 1892		Bensusan, Arthur J., 13, Lansdowne-road, Kensington-park, W., and Box 411, G.P.O., Sydney, N.S.W.
Feb. 20, 1896	Trans.	Bentley, W. H., B.Sc., 182, Liverpool-road, Irlam, near Manchester
Dec. 4, 1890		Bentz, Ernest, 5, Demesne-road, Whalley Range, Manchester
June 21, 1883		Beringer, Cornelius,
Feb. 16, 1882		Beringer, John J., Pendarves-road, Camborne, Cornwall
Dec. 5, 1895		Berkeley, The Earl of, Foscombe, Boar's Hill, near Abingdon

Date of Election.

Mar. 6, 1890

June 15, 1893

Feb. 16, 1888

Dec. 7, 1882

Dec. 3, 1891

Dec. 6, 1888

Mar. 1, 1883

Dec. 2, 1886

Mar. 4, 1897

Dec. 7, 1865

Feb. 18, 1875

Mar. 7, 1872

Dec. 15, 1881

June 4, 1874

Feb. 15, 1894

May 20, 1875

April 17, 1879

Dec. 2, 1886

Dec. 18, 1879

Mar. 5, 1885

Dec. 6, 1883

Mar. 6, 1890

May 15, 1890

June 3, 1875

June 16, 1892

Dec. 4, 1890

Feb. 20, 1896

Feb. 19, 1891

Mar. 6, 1890

Feb. 2, 1888

Dec. 20, 1883

||Berneastle, Richard, 22, Aldridge-road Villas, Bayswater, W.
Berridge, Douglas J. P., M.A., Oxon, The Laboratory, Malvern College

Berridge, Henry Dudley, M.A., Fotheringhay, Oundle, Northamptonshire

||Berry, Edward E., Villa Rosa, Bordighera, Italy

Berry, Thomas William, Granville-terrace, Stone, Staffordshire

Berry, William, 7, Hampton-park, Redland, Bristol

Trans. Bevan, Edward J., 4, New-court, Lincoln's-inn, W.C.

Bevan, John William, care of Sir James Murray and Co., Chemical Works, Temple-street, Dublin

Bhaduri, J. B., M.A., Hoogly College, Chinsurah, Bengal, India

||Bickerdike, W. E., Bryers Croft, Wilpshire, near Blackburn

Biggart, J. W., Chemical Laboratory, 29, Cathcart-street, Greenock

Biggs, C. H. W., 140, Salisbury-court, Fleet-street, E.C.

Bingley, John, Northampton

Bird, Henry, Springfield, Bude, North Cornwall

Bird, William Rowland, 12, Gordon-road, New Swindon, Wilts

Trans. Bischof, Gustav, Prof., 9, Hythe Road, Willesden Junction, N.W.

||Black, A. H., F.R.G.S., St. John's, Wakefield

Blackburn, Thomas, Aruba Phosphaat Maatschappij, Curacao, West Indies

Blackett, Cuthbert R., Laboratory, Swanston-street, Old County Court, Melbourne

Blades, Chas. Mountain, Bay Villa, Chester-road, Northwich, Cheshire

Blair, Frank A., Helsingfors, Finland

Proc. Blake, Robert R. F., Chemical Department, Queen's College, Belfast

Blake, William Henry, Cleadon Tower, near Sunderland

||Blanshard, Charles Thomas, M.A., F.I.C., 3, Seymour Villas, Totnes

Bleckly, Arthur Sanderson, Thelwall Lea, near Warrington

Blenkinsopp, W. E. B., 15, Earlsfield-road, Wandsworth Common, S.W.

||Blood, Maurice, M.A., 3, Stanley Terrace, Clifton-road, Norbiton

Bloomer, Frederick John, F.I.C., 15, Broderick-road, Upper Tooting, S.W.

Trans. Blount, Bertram, Laboratory, Broadway, Westminster, S.W.

Bloxam, Arthur G., F.I.C., The Goldsmiths' Institute, New Cross, S.E., and 16, Bolingbroke-road, W. Kensington, W.

Trans. Bloxam, W. Popplewell, B.Sc., F.I.C., The Davy-Faraday Laboratory, Albemarle Street, W.

Date of Election.

May 16, 1895		Blume, E., P.O. Box 121, The Mexican Gold and Silver Recovery Co., Limited, 2a, de la Providencia No. 7, Mexico D.F., Mexico
Feb. 2, 1865	Trans.	Blunt, T. P., M.A., Tower-place, Shrewsbury
April 21, 1887		Blundstone, Edwin Richardson, B.A., Cornwall Lodge, Hampton Hill, Middlesex
Feb. 20, 1896		Blyde, J. E. A., Nether House, Rammoor, Sheffield
June 3, 1875	Trans.	Blyth, Alexander Wynter, M.R.C.S., 29, Norfolk-road, N.W.
May 5, 1892		Blyth, M. Wynter, B.A., B.Sc., 29, Norfolk-road, N.W.
Dec. 2, 1875		Boake, A., Chemical Works, Stratford, London, E.
Feb. 7, 1878		Bodmer, Richard, Analytical Laboratory, 16, Southwark-street, London, S.E.
Dec. 6, 1888		Bohm, William Dunsmore, A.R.S.M., F.I.C., 49, Avenue-road, Acton, W.
Mar. 18, 1869	Trans.	Bolas, Thomas, 60, Grove-park-terrace, Chiswick
Feb. 1, 1883		Bond, Henry C., M.A., Bromley Park School, Bromley, Kent
May 4, 1893	Trans.	Bone, William Arthur, D.Sc., Ph.D., Owens College, Manchester
Feb. 16, 1893		Boone, W. T., 7, Albert Place, Pittville, Cheltenham
Mar. 1, 1877		Borland, John, F.L.S., Etruria, Kilmarnock
April 17, 1884		Borland, W. D., Beacon Lodge, Green-street Green, near Dartford, Kent
Mar. 17, 1881		Borns, Henry, Ph.D., 19, Alexandra-road, Wimbledon, S.W.
May 16, 1895		Borradaile, L. A., Selwyn College, Cambridge
Feb. 2, 1861		Bosanquet, R. H. M., F.R.S., c/o Messrs. Castle, Lamb and Storr, Salisbury-square, Fleet-street, E.C.
Feb. 15, 1894		Bose, Prof. Chuni Lal, 24, Mohendro Bose's-lane, Calcutta
June 16, 1881		Bostock, G. H., Broadbottom Hall, near Manchester
Dec. 15, 1881	Trans.	Bothamley, Charles H., F.I.C., Otterwood, Beaconsfield-road, Weston-super-Mare
June 16, 1887	Trans.	Bott, William, Ph.D., Singapore, S.S.
Mar. 6, 1873		Bottle, Alexander, 4, Godwyn-road, Dover
June 15, 1871		Bottomley, James, B.A., D.Sc., Homer-terrace, 220, Lower Broughton-road, Manchester
May 15, 1869		Bottomley, James T., M.A., F.R.S., F.R.S.E., 13, University Gardens, Glasgow
Dec. 2, 1886		Bottomley, W. Beecroft, Ph.D., 15, Lillyville-road, Fulham, S.W.
Feb. 15, 1894		Boul, William Good, M.A., Tideswell Grammar School, near Buxton
Dec. 3, 1891		Bovell, John R., Dodd's Botanical and Experimental Station, Barbados
April 20, 1865		Bowdler, A. C., 20, Bank-terrace, Wellington-street, Blackburn
Dec. 6, 1888		Bower, Frank, 164, Marylebone-road, N.W.
May 3, 1894		Bowes, Harry, 53, Moss-bank, Higher Crumpsall, Manchester
Feb. 20, 1896		Bowley, J. J., 34, Elm-park-road, Chelsea, S.W.

Date of Election.

Dec. 7, 1893		Bowman, Frederic Edmund, Mayfield, Knutsford, Cheshire
Nov. 6, 1862		Bowman, Frederick H., F.R.A.S., F.L.S., F.G.S., Mayfield, Knutsford, Cheshire
Feb. 20, 1896		Bowman, H. L., B.A., 13, Sheffield-gardens, Kensington, W.
Dec. 6, 1894	Trans.	Boyd, D. R., B.Sc., Ph.D., The Hartley College, Southampton
May 6, 1897		Boylan, A. H., Maythorne, St. Mary's-road, Doncaster
April 15, 1869		Braby, Frederic, Bushey Lodge, Teddington
May 16, 1895		Bradford, Henry, c/o W. H. Gorrings, Esq., Woodcote, Chichester
Mar. 2, 1876		Bradley, Nathaniel, Sunnyside, 10, College-road, Whalley Range, Manchester
June 21, 1888		Bradshaw, Charles, 10, The Nook, Barber-road, Sheffield
Mar. 17, 1881		Braga, J. F., F.G.S., F.L.S., F.R.G.S., 1, Albert-villas, High-road, Chiswick
Dec. 6, 1894		Brame, J. S. S., Royal Naval College, Greenwich
Nov. 20, 1890		Branson, Charles F., 1 Asgill Gardens, Richmond, Surrey
Dec. 7, 1882		Branson, F. W., 14, Commercial-street, and Wynneholme, Far Headingley, Leeds
June 15, 1882	Trans.	Brauner, B., Ph.D., Spálená ulice, 1, Prague, Bohemia
Feb. 20, 1896		Bray, Daniel, Broadmoor, Cinderford, Gloucester
Dec. 6, 1883		Briant, Lawrence, 24, Holborn-viaduct, E.C.
May 6, 1897		Brierley, James, 12, Brunswick-square, Southampton
Dec. 4, 1890	Trans.	Brierley, John Thomas, 96, Bolton-road, Chorley, Lancashire
May 4, 1893	Proc.	Briggs, John Frederick, Brooklyn, Wimbledon Park Road, Wimbledon, S.W.
April 19, 1883		Briggs, T. Lynton, c/o The American Pegamoid Co., Undercliff, Bergen County, N.Y., U.S.A.
Dec. 18, 1884		Briggs, William, 32, Red Lion-square, Holborn, W.C.
Feb. 6, 1890		Brindley, George F., Niagara Electro-Chemical Company, Niagara Falls, N.Y., U.S.A.
Feb. 17, 1898		Brittain, C. E., B.Sc., 20, Cavendish-square, Margaret street, Hull
April 4, 1889		Broadbent, Harry, A.I.C., 31, Victoria-terrace, Belle Vue-road, Leeds
Feb. 6, 1879		Broadbent, John J., 14, Cross-street, Manchester
Feb. 1, 1883		Brock, John, J.P., Gwern-Tyno, Colwyn Bay, N. Wales
Feb. 16, 1893		Brockbank, John Edwin, The Croft, Kirksanton, viâ Carnforth
Dec. 18, 1884		Brodie, Sir Benjamin V. S., Bart., Brockham Warren, Betchworth
Feb. 16, 1893		Brooke, Edward, West-court, Chalk, Gravesend, Kent
Feb. 17, 1898		Brooks, C. J., 24, Wood-street, Woolwich
Dec. 16, 1886	Trans.	Brothers, H. E., F.I.C., B.Sc. Lond., Park-terrace, Tunstall, Staffs.
June 17, 1897		Brothers, W. M., Beechwood House, Prestwich, near Manchester
Jan. 17, 1884		Brough, Bennett Hooper, A.R.S.M., F.I.C., F.G.S., 28, Victoria-street, S.W.
May 4, 1876	Trans.	Brown, Adrian John, 6, Alexandra-road, Burton-on-Trent

Date of Election.		
Dec. 5, 1867	Trans.	Brown, A. Crum, Prof., M.D., D.Sc., F.R.S., 8, Belgrave-Crescent, Edinburgh
Mar. 17, 1870		Brown, David, 93, Abbey-hill, Edinburgh
June 18, 1891		Brown, Edward, 32, Courlandsky-street, St. Petersburg, and care of Wm. Brown, Heaton-street, Cleckheaton
Mar. 20, 1873	Trans.	Brown, Frederic Douglas, Prof., B.Sc., Univ. Col., Auckland, New Zealand
Mar. 20, 1884		Brown, F. W., 43, Elgin-avenue, Maida Hill, N.W.
May 5, 1892		Brown, George Fitz, The Broughton Copper Company, Ditton, Copper Works, Widnes
June 17, 1897		Brown, G. Noel,
June 17, 1880		Brown, Henry, Cannon Brewery, Watford, Herts
Jan. 19, 1871	Trans.	†Brown, H. T., LL.D., F.R.S., 52, Nevern-square, Kensington, W.
Mar. 7, 1867	Trans.	Brown, James Campbell, D.Sc., 8, Abercromby-square, Liverpool
Mar. 16, 1881		Brown, Joseph, Ashleigh House, Savile Town, Dewsbury
Mar. 4, 1897		Brown, J. H., Ashleigh House, Savile Town, Dewsbury
May 4, 1893		Brown, Ralph E., c/o General Gold Extracting Co., Ltd., 1,530, Wynkoop-street, Denver, Colorado, U.S.A.
May 5, 1892		Brown, Reginald B., Yorkshire College, Leeds
Feb. 19, 1891		Brown, Robert John, M.Sc., The Technical School, Stockport
Dec. 18, 1884		Brown, William George, Ph.D., University of Missouri, Columbia, Missouri, U.S.A.
Dec. 3, 1896		Browne, C. E., 146, The Grove, Hammersmith, W.
Dec. 7, 1893		Browne, Frank, Government Civil Hospital, Hong Kong
Feb. 20, 1873		Brownen, George, Vectis Villa, Gloucester-place, Boscombe, Bournemouth
Dec. 4, 1890		Brownsword, Frank, Shebbear College, Highampton, North Devon
Dec. 6, 1894	Trans.	Bruce, James, The High School, Newcastle, Staffs.
May 16, 1895		Bruckmann, G. T., B.Sc., 192, Eighteenth-street, Brooklyn, N.Y., U.S.A.
Dec. 7, 1893	Trans.	Brunton, John Dixon, Wire Mill, Musselburgh, near Edinburgh
June 21, 1877		Buch, C. von,
June 21, 1877	Trans.	Buchanan, J. Y., F.R.S., 10, Moray-place, Edinburgh
May 4, 1893		Buchanan, Joshua, The Marie Louise Gold Mines, Ltd., P.O., Box 84, Roodeport, S.A.
June 1, 1876		Buckmaster, C. A., 16, Heathfield-road, Mill-hill Park, Acton, W.
Mar. 1, 1852	Trans.	Buckton, G. B., F.R.S., Weycombe, Haslemere, Surrey
June 20, 1878		Budden, E. Russell, 11, Furnival-street, Holborn, E.C.
Feb. 17, 1898	Trans.	Bull, B. S., M.A., B.Sc., Ph.D., 49, Devonshire-road, Greenwich, S.E.
Dec. 20, 1842		Bullock, Lloyd, 3, Hanover-street, Hanover-square, W.

† Longstaff Medallist, 1894.

Date of Election.

Mar. 6, 1890		Bunting, H. H., c/o The Peruvian Corporation, Baquijano, 276B, Lima, Peru
Feb. 20, 1896		Burbridge, J. K., Moor's Lea, Winchmore Hill
Dec. 3, 1891		Burford, Samuel Francis, Eastleigh, Queen's-road, Leicester
Feb. 17, 1898		Burge, C. H., Iddesleigh, Crescent-road, Kingston Hill, S.W.
Feb. 15, 1894	Proc.	Burgess, Herbert Edward, 16, Bloomsbury-street, W.C.
June 19, 1884		Burgess, William Thomas, F.I.C., Beech-road, Reigate Hill
Feb. 21, 1884		Burland, Jeffrey H., 824, Sherbrooke-street, Montreal
Dec. 2, 1897		Burland, R. O., J.P., Poolstock House, Wigan
Dec. 6, 1894		Burman, G. W., Laboratory, The Shelton Iron, Steel, and Coke Co., Limited, Stoke-on-Trent, Staffs.
Mar. 19, 1849	Trans.	Burnard, Charles F., Plymouth Chemical Works, Chatsworth Lodge, Compton Gifford, Plymouth
June 4, 1885		Burnett, Joseph Fearon, 8, River View, Ashton, Preston
May 4, 1893		Burnett, William Robert, Kynock, Limited, Cordite Works, Arklow, co. Wicklow
May 4, 1893		Burnham, John Charles, Gunpowder Factory, Kirkee, Poona, India
May 4, 1882	Trans.	Burrell, B. Arthur, 5, Mount Preston, Leeds
Mar. 6, 1890		Burton, William, Clifton Junction, near Manchester
Feb. 21, 1884		Bush, Richard A., Holmdale, Baron-grove, Mitcham
Feb. 16, 1882		Bush, Baron William de, Messrs. W. J. Bush and Co., Ash Grove, Hackney
Dec. 6, 1894		Bush, William, Austin Villa, Chepstow-road, Newport, Mon.
Dec. 5, 1889		Butcher, W. F.,
Dec. 4, 1890		Butcher, William J., The Grammar School, Ashbourne, Derbyshire
Feb. 21, 1895		Butler, D. Butler, 41, Old Queen-street, Westminster, S.W.
Dec. 4, 1890		Butler, William Waters, The Cedars, Duchess-road, Edgbaston, Birmingham
May 3, 1894		Buttemer, Robt. Wm., St. Mary's, Godalming
June 3, 1875		Butterfield, J. C., 79, Endlesham-road, Balham, S.W.
Feb. 18, 1892		Butterfield, W. J. Atkinson, M.A. Oxon, Ebor House, Redhill
Dec. 15, 1892		Buttfield, Horace Vincent, 13, Wellington-road, Bush Hill Park, Enfield, N.
June 15, 1893		Cahill, Robert S., Brighton Cottage, Brighton-street, Heckmondwike
Dec. 7, 1893		Caines, C. M., 158, Elgin-avenue, Maida Vale, W.
Feb. 17, 1898	Proc.	Caldecott, W. A., B.A., Box 1891, Rand Central Ore Reduction Co., Limited, Johannesburg, S.A.R.
Dec. 3, 1891		Calder, William A. S., Cawdor, 47, Grove Park, Camberwell, S.E.
June 19, 1884		Caley, Edward J., Eaton Old House, Norwich
June 18, 1896		Caley, John, 41, Norfolk-street, Beverley-road, Hull

Date of Election.	
Dec. 21, 1871	Calvert, J. H., Oakenshaw Print Works, near Accrington
Dec. 6, 1894	Cameron, Alex., Rosbacher Brunnen, bei Friedburgh, Hessen, Germany
June 17, 1875	Cameron, J. Macdonald, F.G.S., F.I.C., Royal Mint, Sydney, N.S.W.
May 4, 1893	Cameron, James, 7, Bolton-road, Port Sunlight, near Birkenhead
Dec. 2, 1897	Cameron, A. M., Daylesford, Victoria, Australia
June 17, 1897	Cameron, E. S., 51, Pembroke-road, Dublin
Dec. 15, 1892	Campbell, Andrew, Burmah Oil Works, Dunneedaw, Rangoon, Burmah
Dec. 6, 1888	Campbell, J. Morrow, B.Sc., F.R.G.S., c/o J. Morrow, Esq., Oakfield House, Anfield, Liverpool
June 7, 1888	Campbell, Rev. Joseph, St. Nicolas College, Randwick, N.S.W.
April 21, 1898	Campion, Alfred, 637, Alexandra Parade, Dennistoun, Glasgow
Feb. 20, 1896	Candy, Hugh, B.A., B.Sc., 101, Gower-street, W.C.
Mar. 20, 1884	Cannon, Matthew, Chemical Works, Wickersley-road, Lavender Hill, S.W.
Feb. 17, 1898	Cannon, M. J., 101, The Chase, Clapham Common, S.W.
Feb. 16, 1888	Carey, Alfred Edward, M.Inst.C.E., F.R.G.S., F.G.S., 39, Trinity-square, Tower Hill, E.C.
May 5, 1892	Carey, Arthur, B.Sc., Browside, Gateacre, near Liverpool
Feb. 21, 1889	Carmody, P., Prof., F.I.C., Government Laboratory, Port of Spain, Trinidad
May 6, 1875	Carpenter, H. S., F.I.C., Beckington House, Weighton-road, Anerley, S.E.
Feb. 21, 1895	Trans. Carr, Francis H., 27, Miskin Road, Dartford
Nov. 17, 1887	Carrington, George Carrington, Missenden Abbey, Great Missenden, Bucks
Dec. 7, 1882	Carruthers, Robert, 90, High-street, Dumfries
Dec. 7, 1893	Carswell, Thomas Retson, 17, Charlotte-street, Old Kent-road, S.E.
June 16, 1864	Carteighe, Michael, 180, New Bond-Street, W.
Mar. 4, 1897	Cartmell, Alfred, Alexander-road, Burton-on-Trent
Dec. 5, 1867	Carulla, F. J. R., 84, Argyle-terrace, Rose Hill, Derby
Feb. 21, 1895	Case, T. B., B.A., 82, St. James'-street, Dublin
Feb. 6, 1879	Cassal, C. E., Vestry Hall, Mount-street, Grosvenor-square, W.
Dec. 6, 1894	Catherall, Ezra, Heathmere, Albany-road, Harborne, Birmingham
April 21, 1898	Proc. Caven, R. M., University College, Nottingham
Mar. 5, 1874	Chaloner, George, 30, Weston-park, Crouch End, N.
Dec. 2, 1880	Chamberlain, A. G., Rugby
Dec. 6, 1894	Chambers, J. F., Grammar School, Dursley, Gloucestershire
Dec. 20, 1883	Chambres, Gordon Crewe, Rev., Grammar School, Wigan
Feb. 1, 1883	Chance, Alexander M.,
Feb. 1, 1872	Chandler, Charles F., Ph.D., Columbia College, 51, East 54th-street, New York

Date of Election.

Feb. 1, 1872		Chandler, William H., Prof., Lehigh University, Bethlehem, Pennsylvania
Feb. 21, 1889		Chaplin, Edward Mitchell, Ph.D., 60, Westgate, Wakefield
Dec. 5, 1895		Chapman, A. J., Burleigh House, Yerbury-road, Upper Holloway, N.
June 17, 1886	Trans.	Chapman, Alfred C., F.I.C., 23, Leadenhall-street, E.C.
Jan. 16, 1868		Chapman, Edward, Hill End, Mottram, Manchester
Dec. 18, 1884		Chapman, Herbert M., The War and Sporting Smokeless Powder Company, Trimley, Suffolk
May 7, 1891		Charles, Rhys Pendrill, Plâs Newydd, Neath
Feb. 15, 1894	Trans.	Chattaway, F. D., D.Sc. Lond., Ph.D. Mun., B.A. Oxon., Chemical Laboratory, St. Bartholomew's Hospital, E.C.
Dec. 5, 1895		Chattaway, W., Apothecaries' Hall, E.C.
May 16, 1895		Cheadle, Walter W., B.A., 19, Portman-street, W.
Dec. 4, 1890		Cheetham, T. A., Allan Glen's School, 68, North Hanover-street, Glasgow
Dec. 5, 1878		Cheshire, H. F., Public Analysts' Laboratory, Hastings
Jan. 19, 1882		Chester, Edward D.,
Dec. 16, 1875		Cheverton, George, F.L.S., South Lawn, Tunbridge Wells
Mar. 4, 1897		Chikashigé, Masumi, B.Sc., Kumamoto, Japan
Dec. 21, 1871		Childs, Christopher, M.D., Oxon, 10, Manchester-square, W.
Mar. 4, 1897		Cholerton, A. F., Lyndum House, Lincoln-street, Leicester
Dec. 3, 1891	Trans.	Chorley, John C., Lodge-lane, Bewsey, Warrington
Dec. 17, 1885		Christopher, G., Walkden Works, Verney-road, Bermondsey, S.E.
Dec. 7, 1882		Chrystal, William J., 7, West George-street, Glasgow ; and Shawfield Works, Rutherglen, near Glasgow
Mar. 3, 1856	Trans.	Church, Arthur Herbert, F.R.S., Shelsey, Kew, Surrey
April 19, 1888	Trans.	Claisen, Ludwig, Prof., Ph.D., Chemisches Institut, Brunswickerstrasse 2, Kiel
Dec. 15, 1892		Clark, Ernest Victor, 34, St. Aubyns, Hove, Sussex
Dec. 7, 1876	Trans.	Clark, John, Ph.D., 138, Bath-street, Glasgow
Dec. 2, 1897		Clarkson, Alexander, 2, Waveney-crescent, Ballymena, Ireland.
Feb. 16, 1852	Trans.	Claudet, Frederic, 6, Coleman-street, E.C.
April 15, 1886		Clayden, Arthur W., M.A., F.G.S., St. John's, Polsloe-road, Exeter
Dec. 7, 1882		Clayton, E. Goodwin, F.I.C., 32, Holborn-viaduct, E.C.
May 4, 1893		Clayton, George, School of Pharmacy, 100, Burlington-street, Manchester
Feb. 21, 1889		Clayton, John William, Bentfield, Alma-road, Aigburth, Liverpool
Dec. 4, 1873	Trans.	Cleminshaw, Edward, M.A., Alkali Works, Oldbury, near Birmingham
May 20, 1875		Clerk, Dugald, 18, Southampton-buildings, Chancery-lane, W.C.

Date of Election.	
May 19, 1856	Clift, Samuel, 63, Dudley-road, West Bromwich
Feb. 7, 1878	Cloud, Thomas Charles, A.R.S.M., Walaroo Smelting Works, Walaroo, South Australia
Mar. 18, 1869	Trans. Clowes, Frank, D.Sc., 18, Bedford Court Mansions, Bedford-square, W.C.
June 17, 1897	Clutterbuck, M. C., B.Sc., Ph.D., 61, Beaconsfield-villas, Brighton
Feb. 3, 1887	Coates, William Henry, M.A., M.B., L.S.Sc., M.R.C.S., L.R.C.P., L.S.A., Bleak House, Patrington, Yorkshire
Dec. 3, 1896	Cobb, W. W., M.A., Hilton House, Atherstone
Mar. 6, 1890	Cobbold, Paul Alexander, M.A., Haileybury, Ontario, Canada
May 16, 1895	Coblentz, V., 115-119, W. 68th-street, New York
Dec. 18, 1879	Cochran, Michael, M.A., Wiesbaden, Kollupitiya, Colombo, Ceylon
Dec. 2, 1880	Cockburn, Arthur Cecil, 22, Streatley-road, Brondesbury, N.
Dec. 5, 1895	Trans. Cockburn, G. B., B.A., St. George's Hospital, S.W.
Dec. 7, 1893	Cocking, Allan Thomas, Rowley, Robert-road, Handsworth, Birmingham
Feb. 16, 1888	Cocking, Lewis Smith, Wharf Mills, Apsley, Huddersfield
Feb. 17, 1881	Coffin, Walter H., 94, Cornwall-gardens, South Kensington, and Junior Athenæum Club, S.W.
Mar. 5, 1885	Trans. Cohen, Julius B., Ph.D., Yorkshire College, Leeds
Feb. 19, 1891	Trans. Colefax, Arthur, Ph.D., M.A., 4, Brick-court, Temple. E.C.
April 19, 1883	Coleman, Joseph Bernard, S.W. Polytechnic Institute, Manresa-road, Chelsea, S.W.
June 21, 1883	Coleman, T. H., Bryn Edwyn, Regent-street, Wrexham
Mar. 1, 1883	Collenette, Adolphus, 11, Commercial-arcade, Guernsey
Nov. 6, 1873	Collens, Edward, Stourbank House, Stourport, Worcestershire
June 16, 1881	Collett, John Marton, Guys Cliff, Wotton, Gloucester
Feb. 5, 1885	Trans. Collie, J. Norman, Ph.D., F.R.S., 16, Campden-grove, Kensington, W.
Feb. 18, 1892	Collins, Hugh Brown, B.Sc., 121, West George-street, Glasgow
Feb. 6, 1890	Collins, Sydney Hoare, c/o Messrs. Grindley and Co., 55, Parliament-street, S.W.
Feb. 16, 1888	Collins, W. Hepworth, c/o O. M. Whil, Esq., LL.B., 34, Kennedy-street, Manchester
Dec. 2, 1897	Collingridge, Frank, B.Sc., Kenmore, Shepherd's Hill, Highgate, N.
Mar. 17, 1887	Trans. Colman, Harold G., Ph.D., 23, Stirling-road, Edgbaston, Birmingham
May 15, 1890	Colwell, James Kear, F.I.C., Clerkenwell Town Hall, Roseberry-avenue, E.C.
May 5, 1892	Comyns, Frank B. A., 6, Montague-terrace, Newbury, Berks
June 18, 1891	Congdon, Prof. Ernest A., The Drexel Institute of Art, Science and Industry, Chestnut-street, Philadelphia, Penn, U.S.A.

Date of Election.

Feb. 18, 1875		Connor, Charles C., B.A., Notting-hill House, Malone, Belfast
April 19, 1883		Conrad, Edwin C., Manor House, Chaik, Gravesend
Jan. 18, 1866	Trans.	Conroy, Sir John, Bart., F.R.S., Balliol College, Oxford
Dec. 2, 1875	Trans.	Cook, E. H., D.Sc. (Lond.), the Clifton Laboratory, 27, Berkeley-square, Clifton, Bristol
Nov. 5, 1874		Cook, Edward Rider, East London Soap Works, Bow
May 16, 1895		Cook, Herbert W., Prestburg-villa, Park-lane, Macclesfield
Dec. 4, 1890		Cooke, Arthur William, c/o Messrs. Brotherton and Co., Holmes-street, Dewsbury-road, Leeds
Feb. 2, 1888		Cooke, F. Barker, F.I.C., Messrs. Bostock and Co., South Dock, Garston, near Liverpool
Nov. 15, 1888		Cooley, Walter Bromley, 5, Dudley-street, Wolverhampton
Jan. 17, 1889		Cooper, Albert, Grimston Lawn, Haven Green, Ealing, W.
Feb. 17, 1897		Cooper, A. J. Bullen, Grimston Lawn, Ealing, W.
Dec. 15, 1892		Cooper, Arthur James, Harris Institute, Preston
Feb. 16, 1888		Cooper, Astley, Oatlands Chemical Works, Meanwood-road, Leeds
May 7, 1891		Cooper, Walter Johnson, South Wales Cement Works, Penarth, near Cardiff
Feb. 17, 1897		Cooper, W. R., M.A., 87, Upper Tulse-hill, S.W.
Dec. 6, 1894	Proc.	Coote, A. H., 1, Mycene-road, Blackheath, S.E.
Feb. 6, 1890		Coppock, J. B., Harris Institute, Preston
Feb. 19, 1891	Trans.	Corbett, Charles Henry, the Avenue, Trowbridge, Wilts
Mar. 1, 1866		Corfield, W. H., M.A., M.D. (Oxon), F.G.S., Professor of Hygiene and Public Health, University College, W.C., and 19, Saville-row, W.
Dec. 6, 1888		Cornish, Vaughan, Branksome Cliff, Bournemouth
April 17, 1890		Corrie, David, Nobel's Explosives Company, West Quarter Factory, Polmont Station, N.B.
Dec. 3, 1891		Cory, G. E., M.A., St. Andrew's College, Grahamstown, S.A.
June 15, 1893	Trans.	Coste, John Henry, 206, Amhurst-road, Hackney, N.E.
June 16, 1892		Couldrey, Henry, H.M.'s Mint, Bombay, India
Dec. 17, 1885		Cousins, William J., 11 and 12, Southampton-buildings, Chancery-lane, W.C.
Dec. 16, 1886	Trans.	Coutts, Francis J. H., Cromar, 131, Plymouth-grove, Manchester
Dec. 7, 1882		Cowie, Thomas R., Merchant-street, Rangoon, Burmah
Feb. 17, 1898		Cowling, Frederick, Technical Schools, Clay Cross, near Chesterfield
Feb. 6, 1873		Cownley, Alfred J., 13, Fenchurch-avenue, E.C.
April 19, 1888		Cowper, Joseph, 50, King-street, Penrith
Dec. 2, 1886		Cox, Ebenezer John, 114, Greenfield-road, Harborne, Birmingham
Dec. 4, 1873		Cox, Samuel Herbert, 13, St. Helen's-place, London, E.C.
Dec. 1, 1870	Trans.	Crafts, Prof. J. M., 59, Marlborough-street, Boston, Mass., U.S.A.
Dec. 15, 1892		Craig, Andrew William, 77, Peel-street, North Melbourne, Victoria

Date of Election.		
Feb. 20, 1896		Craig, James, M.A., B.Sc., 4, West Garden-street, Glasgow
June 3, 1875		Crampton, George,
June 17, 1897		Cranfield, William, 5, Second-avenue, Halifax
Dec. 7, 1893		Craw, John A., Royal College of Science, South Kensington, S.W.
Mar. 16, 1882		Crawley, H. Howard, 2, Anerley-road, Bournemouth
Mar. 4, 1897		Creasey, C. H., 78, Baggeholme-road, Lincoln
May 20, 1875		Cresswell, Charles Gerard, Ermyngarth, Ashtead
Mar. 3, 1887		Cribb, Cecil H., B.Sc., 136, Shaftesbury-avenue, W.
April 4, 1889		Cridland, Francis E. J., Analytical Laboratory, 192, Palmerston-buildings, Old Broad-street, E.C.
June 20, 1878		Criper, William Risdon, Chemical Works, Konnagar, Calcutta
Dec. 5, 1895		Crocker, C., St. Peter's-road, Cockett, Swansea
Dec. 2, 1897	Trans.	Crofts, J. M., B.A., Emmanuel College, Cambridge
May 20, 1886	Trans.	Crompton, Holland, Heath-house, New End-square, Hampstead
Dec. 3, 1857	Trans.	Crookes, Sir William, F.R.S., 7, Kensington Park-gardens, W., and Athenæum Club, Pall Mall, S.W.
Feb. 6, 1879	Trans.	Cross, Charles Frederick, 4, New-court, Lincoln's-inn, W.C.
Dec. 3, 1896		Cross, G. H., B.Sc., Karachi, India
Dec. 4, 1890	Trans.	Crossley, Arthur W., M.Sc. (Vict.), Ph.D., Chemical Laboratory, St. Thomas's Hospital, S.E.
June 18, 1896		Crossman, C. M., B.Sc., 23, Euston-buildings, N.W.
Feb. 21, 1895		Crossman, Tom, 40, Coldhurst-street, Oldham
Dec. 2, 1880	Trans.	Crow, John Kent, D.Sc., Tressillian, Ulandi-road, Blackheath, S.E.
Dec. 1, 1887		Crowther, H. Woodward, The Beeches, West Bromwich
Mar. 4, 1897		Crowther, James, B.Sc., West-field, Lightcliffe, Halifax
June 20, 1895		Croysdale, John, Whitley Bridge, R.S.O., Yorkshire
June 19, 1884		Crumbie, William D., 146, Washington-street, East Orange, New Jersey, U.S.A.
Mar. 17, 1887	Trans.	Cundall, J. Tudor, B.Sc., Edinburgh Academy, Henderson-row, and 1, Dean-park-crescent, Edinburgh
Dec. 27, 1875		Curphey, W. S., Borva, Lenzie, N.B.
Dec. 15, 1881		Custance, John D., Prof. of Agriculture, Forest-hill-house, near Newport, Isle of Wight
Dec. 5, 1895		Cuthbertson, Gurney, 69, Shoreham-street, Sheffield
Feb. 15, 1894		Dains, Herbert H., F.I.C., 3, Cantonment, Vizianagram, India
Dec. 7, 1882		Dampier, Henry L., Lyndhurst, Tankerton, Whitstable, Kent
Dec. 2, 1897		Daniell, John, Council of Education Laboratory, Johannesburg, S.A.R.
June 16, 1887		Daniell, L. C., Royal Standard Brewery, Tamworth, N.S.W.
April 15, 1850		Danson, Joseph,
Feb. 18, 1892		Darbishire, Francis V., Rossplatz 12, I., Leipzig

Date of Election.

Nov. 15, 1852		Darby, Stephen, 140, Leadenhall-street, E.C.
Dec. 3, 1891		Darling, Thomas, Adderstone House, Berwick-on-Tweed
May 4, 1871	Trans.	Darling, William Howarth, 126, Oxford-street, Manchester
Nov. 8, 1886		Davenport, Bennett F., M.A., M.D., 161, Tremont-street, Boston, Mass., U.S.A.
Nov. 18, 1875		Davey, G. W., Bleak House, Barking Creek
Feb. 16, 1893		Davey, George, c/o The Waitekauri Gold Mines, Ltd., Waitekauri, Auckland, N.Z.
May 6, 1897		Davidge, H. N., 37, Duke-street, Grosvenor-square, W.
May 18, 1876		Davidson, Joseph, 72, Harley-road, Harlesden, N.W.
Feb. 1, 1866	Trans.	Davies, Arthur E., Ph.D., Tweedbank, West Savile-road, Edinburgh
May 6, 1858	Trans.	Davies, Edward, The Laboratory, 28, Chapel-street, Liverpool
Feb. 16, 1882	Trans.	Davies, G. W., 8, Spring-hill, Stockport
Feb. 15, 1894		Davies, S. H., Rowntree's Cocoa Works, York
June 18, 1896		Davies, L. J., Bute Chambers, Bute-road, Cardiff
Dec. 17, 1857		Davis, J. Frederick, F.G.S., Archbrook, Budleigh-Salterton, Devon
June 6, 1872	Trans.	Davis, Richard Hayton, 26, Regent-parade, Harrogate
Jan. 20, 1876		Davis, T. Sebastian, 199, South Lambeth-road, S.W.
Mar. 4, 1897	Proc.	Davis, W. A., Central Technical College, South Kensington, S.W.
Dec. 7, 1876		Davis, Walter Charles, The Chestnuts, Durdham Down, Bristol
Feb. 21, 1895		Daw, F. W., Eureka-place, Ebbw Vale, Monmouthshire
Nov. 20, 1890		Day, Charles Edwin, 145, Abbey-road, Barrow-in-Furness
Mar. 17, 1881	Trans.	Day, T. Cuthbert, 36, Hillside-crescent, Edinburgh
Mar. 4, 1886		Deane, Leopold M., 24, Newton-road, Faversham
Mar. 3, 1859	Trans.	Debus, Heinrich, Ph.D., F.R.S., 4, Schlangenberg, Cassel, Provinz Hessen, Germany
May 7, 1885	Trans.	Dechan, Martin, Laboratory of Public Analyst, Hawick
Dec. 3, 1874		Deck, Arthur, 9, King's-parade, Cambridge
April 1, 1869	Trans.	Deering, W. H., Chemical Dept., Royal Arsenal, Woolwich, S.E.
Dec. 15, 1881		Demarcay, Eugene Anatole, 8bis, Bd. de Courcelles, Paris
Dec. 15, 1892		Denison, Joseph R., 1, Park-view-terrace, Manningham, Bradford
Mar. 6, 1890		Dennant, John, F.G.S., Russell-street, Camberwell, Victoria
May 6, 1897		Deverell, L. C., 30/31, St. Swithin's Lane, E.C.
Dec. 1, 1870	Trans.	Dewar, James, Prof., M.A., LL.D., F.R.S., Royal Institution, Albemarle-street, W.
Mar. 4, 1886		Dey, Preo Lall, 4, Beadon-street, Calcutta
June 17, 1880		Dey, Kanny Lall, Rai Bahadur C.I.E., 4, Beadon-street, Calcutta
Mar. 4, 1897		Diamond, William, Pyebridge, Alfreton, Derbyshire
April 15, 1880		Dibdin, W. J., F.I.C., Mayfield, Grange-road, Sutton, Surrey
April 18, 1872		Dickenson, Arthur John, F.I.C., 4, Shardeloes-road, New Cross, S.E.
May 4, 1893		Dickinson, Henry Winram, South Kensington Museum, S.W.

Date of Election.		
Dec. 1, 1887		Dickson, T. Arthur, Estate Office, Overstone Park, Northampton
Feb. 2, 1860	Trans.	Divers, Edward, Prof., M.D., F.R.S., Hongo, Tokyo, Japan
Dec. 2, 1897		Dixon, A. J., c/o The Smelting Co. of Australia, Dapto, N.S.W.
Feb. 5, 1885	Trans.	Dixon, Augustus Edward, M.D., Queen's College, Cork
Feb. 20, 1896		Dixon, Frank, B.Sc., The Foundation School, Whitechapel-road, E.
June 7, 1894		Dixon, George, M.A., Trinity College, Cambridge and St. Bees, S.O., Cumberland
Feb. 3, 1876	Trans.	Dixon, Harold B., F.R.S., Owen's College, Manchester
May 4, 1893		Dixon, Harry W., 20, Moor-crescent, Hunslet, Leeds
Dec. 5, 1895		Dixon, W., 102, Spring-street, Bury
Dec. 18, 1862		Dixon, W. A., 97, Pitt-street, Sydney, N.S.W.
April 17, 1890		Dixon, William, 4, Park-place East, Sunderland
June 15, 1882	Trans.	Dobbie, James Johnstone, Prof., M.A., D.Sc., University College, Bangor, N. Wales
Mar. 3, 1887	Trans.	Dobbin, Leonard, Ph.D., Chemical Laboratory, New University-buildings, Edinburgh
Feb. 17, 1898		Dodd, F. R., 1, Wesley-street, Upper Stanhope-street, Liverpool
Dec. 2, 1875	Trans.	Dodd, T. H., Chemical Department, Royal Arsenal, Woolwich, S.E.
April 19, 1888		Dodd, William Henry, 8, Kempson-road, Walham-green, S.W.
Nov. 18, 1886		Dodd, W. Ralph, Oakdene, Bush-hill Park, Enfield
May 5, 1892		Dodds, George Price, 40, Greenbank-road, Darlington
Mar. 4, 1897		Dodgson, J. W., B.Sc., Eversley, Llewellyn-street, Aberdare, S. Wales
Dec. 6, 1894	Proc.	Doherty, W. M., Government Laboratory, Sydney, N.S.W.
May 5, 1892		Donaldson, Hudson, The Laurels, St. Catharine's-road, Grantham
Feb. 17, 1897	Trans.	Dootson, F. W., M.A., Bryn, Glisson-road, Cambridge
May 20, 1886	Trans.	Doran, Robert Elliott, Chemical Dept. Queen's College, Cork
May 20, 1886		Dormer, Richard, Garston
Dec. 6, 1888		Douglas, William, F.I.C., Diamond, Demerara, British Guiana
Nov. 20, 1884		Down, Frederick J., Glengariff, Milton-road, Harpenden, Herts.
Feb. 3, 1887		Downes, Arthur H., M.D., Local Government Board, Whitehall, S.W.
Feb. 21, 1884		Draper, Henry Carter, The Lodge, Clonsilla, co. Dublin
June 18, 1891		Dreaper, W. Porter, Clifton Villa, Coggeshall-road, Braintree, Essex
Feb. 16, 1893		Dreyfus, Charles, Ph.D., The Clayton Aniline Co., Clayton, Manchester
May 16, 1895		Druce, E., Agricultural College, Holmes Chapel, Cheshire
May 6, 1897		Duckham, Alexander, 40, Croom's-hill, Greenwich-park, S.E.
Dec. 4, 1890		Dudley, William L., Prof. Vanderbilt Univ., Nashville, Tennessee, U.S.A.
Feb. 16, 1893	Trans.	Dufton, Samuel Felix, M.A., D.Sc., Dingley, Upper Bridge-road, Red Hill, Surrey

Date of Election.

Mar. 4, 1897		Duffy, Lawrence, 33, Broomhall-place, Sheffield
May 5, 1892		Duffield, Walter William, 5, Ashington-road, Parson's-green, S. W.
Feb. 21, 1884		Duggan, T. R., Sunny-bank, Vanburgh-hill, Westcombe-park, Blackheath, S.E.
Jan. 17, 1889		Duisberg, Dr. Carl, Elberfeld, Germany
Dec. 5, 1889		Dukes, Thomas William, P. T. Peterson and Co., P.O. Box 210, Johannesburg, S.A.R.
June 16, 1881		Duncan, Arthur W., 42, Trevelyan-street, Eccles, Manchester
Dec. 6, 1894	Proc.	Duncan, C. C., Royal Agricultural College, Cirencester
Dec. 17, 1863		Duncan, James, 9, Mincing-Lane, E.C.
Feb. 15, 1894		Duncan, Dr. John, St. Petersburg, Russia
June 18, 1891		Duncan, William, The Laboratory, 65, Bath-row, Edgbaston, Birmingham
Dec. 3, 1896		Duncan, William, Royal Dispensary, 21, W. Richmond-street, Edinburgh
Dec. 6, 1894	Proc.	Dunn, Fred., 316, Flinders-lane, Melbourne
June 7, 1888		Dunn, John, B.Sc., Morgan Academy, Dundee
Dec. 7, 1882		Dunn, J. T., D.Sc., Northern Polytechnic Inst., Holloway, N.
Feb. 16, 1893		Dunnington, Francis P., University of Va, Charlottesville, U.S., N.A.
Dec. 3, 1885		Dunstan, M. J. R., M.A., F.R.S.E., Newcastle Circus, The Park, Nottingham
Dec. 18, 1879	Trans.	Dunstan, Wyndham R., Prof., M.A., F.R.S., Scientific Department, Imperial Institute, S.W.
Jan. 19, 1860	Trans.	Dupré, August, Ph.D., F.R.S., Edinburgh Mansions, Hawick Place, S.W.
May 7, 1896		Durant, H. T., P. O. Box 1891, Rand Central Ore Reduction Co., Johannesburg, S.A.R.
June 1, 1871		Durham, Henry, 32, Fitzroy-street, Fitzroy-square, W.
Dec. 6, 1883	Proc.	Durrant, Reginald G., M.A., The College, Marlborough, Wilts.
Dec. 6, 1883		Dutta, Ramchandra, Medical College, Calcutta
Dec. 15, 1892		Duxbury, Thomas, 4, Grosvenor-chas., Deansgate, Manchester
Dec. 16, 1875	Trans.	Dyer, Bernard, D.Sc., (Lond.), 17, Great Tower-street, E.C.
Feb. 6, 1890	Trans.	Dymond, Thomas Southall, 78, Duke-street, Chelmsford
Nov. 19, 1885	Trans.	Dyson, Gibson, Ph.D., Homefield, Middleton-road, Higher Crumpsall, Manchester
Mar. 1, 1883	Trans.	Dyson, Septimus, 2, Exchange-placo, Middlesbrough
Feb. 7, 1882		Earl, Alfred George, M.A., Ferox Hall, Tonbridge
Dec. 1, 1876		Earp, Francis S., Ph.D., Hannan's Brown Hill Mine, Kalgoorlie, W.A.
April 4, 1889	Trans.	Easterfield, Thomas Hill, M.A., Ph.D., 60, Bateman-street, Cambridge

Date of Election.		
Dec. 3, 1891		Eastick, Charles E., Martineau's Refinery, King Edward-street, Whitechapel, E.
Feb. 1, 1881		Eastick, John J., Millaquin Refinery, Bundaberg, Queensland
Dec. 5, 1878	Trans.	Eccles, Herbert, Lon Lâs, Neath, Glamorganshire
Mar. 17, 1881		Edgell, R. Arnold, Rev., M.A., The College House, Leamington
June 1, 1876		Edmunds, James, M.D., 28, Dover-street, Piccadilly, W.
Feb. 7, 1848	Trans.	Edwards, John B., Ph.D.
May 4, 1893		Edwards, Thomas, Brewery House, Rhymney, viâ Cardiff
Feb. 21, 1884		Edwards, Vincent, Lawes' Chemical Manure Co., Barking Creek, Essex
Mar. 4, 1897		Edwards, W. B., 5, Garlinge-road, Brondesbury, N.W.
May 5, 1892		Edwards, Walter N., 4, Herne Hill-road, Camberwell, S.E.
June 16, 1887		Ehrhardt, Ernest Francis, D.Sc., Ph.D., A.M.C. Badische Anilin und Soda Fabrik, Ludwigshafen-am-Rhein, Germany
Nov. 20, 1884		Ehrmann, Leon
Feb. 20, 1896		Eiloart, Arnold, B.Sc., Ph.D., The Colony, Purleigh, Essex
Dec. 1, 1864	Trans.	Ekin, Charles, 143, New Bond-street, W.
Dec. 20, 1883		Ekins, Arthur E., County Laboratory, St. Albans
Nov. 17, 1887		Elborne, William, B.A. (Cantab.), University College Hospital, W.C.
Dec. 3, 1891		Elford, Percy, St. John's College, Oxford
Feb. 7, 1878		Elliott, Arthur H., Ph.D., c/o Consolidated Gas Co., 4, Irving-place, New York City, U.S.A.
Dec. 3, 1896	Trans.	Elliott, W. J., M.A., Grammar School, Bristol
Dec. 7, 1893		Ellis, C. Sordes, A.I.C., 4, Queen's-villas, Dickenson-road, Rusholme, Manchester
April 17, 1890		Ellis, Thomas Flower, Widmore, Bromley, Kent
Feb. 7, 1878		Ellis, W. H., School of Practical Science, Toronto, Ontario, Canada
May 5, 1892		Ellison, Henry, junr., Whitechapel-road, Cleckheaton
Mar. 15, 1888		Ellwood, Thomas Ashcroft, 75, Cavendish-road, Haringay, N.
Feb. 16, 1893		Elmore, Alexander Stanley, The Old Hall, Knopstrop, near Leeds
Mar. 4, 1886	Trans.	Elworthy, Herbert Samuel, 2, Peel Terrace, Havre-des-Pas, Jersey
Feb. 5, 1885		Embrey, George, County Laboratory, Brunswick-road, Gloucester
Feb. 3, 1887		Emmons, Hamilton
June 16, 1892		Entwistle, Herbert, 1, Albert-place, Dickenson-road, Longsight, Manchester
Dec. 3, 1885		Epps, James, junr., Norfolk House, Beulah Hill, Upper Norwood, S.E.
Dec. 5, 1889		Erskine, J. Kerr, New Kleinfontein Co. (Per Private bag), Johannesburg, S.A.R.
June 21, 1883	Trans.	Esilman, Alexander, Fleetwood Lodge, 25, Roe-lane, Southport
May 1, 1862		Esson, William, Prof., F.R.S., Merton College, Oxford
Feb. 2, 1865		Estcourt, Charles, 20, Albert-square, Manchester

Date of Election.

Feb. 2, 1888		Estcourt, Philip Anderson, Chemical Laboratory, 20, Albert-square, Manchester
June 7, 1894		Eumorfopoulos, Nicholas, B.Sc., 1, Kensington Park-gardens, W.
Mar. 16, 1895		Eutroppe, A. T., Vancouver, Washington, U.S.A.
May 7, 1891		Evans, Frederick Arthur, The Cape Copper Co., Ookiep, Namaqualand, Cape of Good Hope
June 15, 1876		Evans, Gwilym, 7, Stepney-street, Llanelly, South Wales
May 4, 1893	Trans.	Evans, Robert Cecil Turle, 2, Clarence-road, Brondesbury
June 16, 1892		Evans, Sir John, K.C.B., D.C.L., LL.D., F.R.S., Nash Mills, Hemel Hempstead
Dec. 6, 1888		Everard, Arthur George, Normanhurst, 115, Broomwood-road, Wandsworth Common, S.W.
Feb. 15, 1894		Evershed, Frank, Kenley, Surrey
Feb. 20, 1896	Trans.	Ewan, Thomas, M.Sc., Ph.D., The Aluminium Co., Ltd., Oldbury, near Birmingham
Dec. 3, 1896		Ewen, E. D., c/o The West Indian Tobacco Co., Port of Spain, Trinidad
Mar. 15, 1888		Faber, Harold N., Fiona, Lennard-road, Penge, S.E.
May 18, 1865	Trans.	Fairley, Thomas, F.R.S.E., 17, East-parade, Leeds
Feb. 1, 1883		Fallon, J. H. M.,
Nov. 15, 1888		Farlie, John B., 39, Ripon-road, Plumstead, S.E.
Feb. 21, 1895		Fairrie, Henry, 253, Vauxhall-road, Liverpool
Dec. 5, 1895		Farr, E. H., Uckfield, Sussex
Dec. 1, 1870		Farries, Thomas, 16, Coleman-street, E.C.
Dec. 2, 1880		Farrington, Thomas, M.A., 5, Summerhill-terrace, Wellington, Cork
Dec. 5, 1895		Fauvel, C. J., Laboratory, Cranford, Middlesex
Feb. 15, 1894		Fawcett, Joseph Addey, 54, Broxholme-road, Doncaster
May 16, 1895		Fawns, Sidney, F.G.S., A.I.M.M., P.O., Coolgardie, W.A.
Dec. 1, 1887		Fawsitt, Charles A., 9, Foremount-terrace, Dowanhill, Glasgow
May 17, 1888		Fell, John Campbell, 45, Gifford-street, N.
May 6, 1897		Fenby, A. V. C., B.Sc., Hutton Grammar School, nr. Preston
Dec. 5, 1878	Trans.	Fenton, H. J. H., M.A., Christ College, Cambridge, and 7, Mortimer-road, Cambridge
June 20, 1872		Ferguson, John, Prof., M.A., University of Glasgow
Feb. 4, 1864		Ferreira, A. A., M.P.S.
Feb. 21, 1889		Ferrier, David, 1, Edin-terrace, Perth
Nov. 16, 1882		Ferrier, James, Columbus, Georgia, U.S.A.
May 6, 1897		Field, C. H., The Elms, Green Street Green, Orpington, Kent
Dec. 5, 1895		Fielding, P. J. D., 8, St. Joseph's-place, Cork
May 15, 1890		Findlay, George H., Burmantoft's Brewery, Leeds
May 7, 1896		Fisher, E. H., The County Laboratory, St. Albans
Mar. 7, 1872	Trans.	Fisher, Walter William, M.A., 5, St. Margaret's-road, Oxford

Date of Election.

April 3, 1873		Fison, Edward Herbert, Stoke House, Ipswich
April 18, 1872		Fison, Frederick William, M.A., 64, Pont-street, S.W.
Feb. 15, 1894		FitzGerald, Rev., Henry Purefoy, M.A., F.L.S., Wellington College, Berks
Dec. 3, 1896		Fleet, J. T., 24, Sheep-street, Rugby
April 21, 1898		Fleming, J. A., Britannia Pottery, Glebe-street, Glasgow
April 16, 1874		Fletcher, Frederick W., North London Chemical Works, Holloway, N., and Beauchamp Lodge, Enfield
Dec. 3, 1885		Fletcher, Lazarus, M.A., F.R.S., Natural History Department, British Museum, Cromwell-road, S.W.
April 18, 1872	Trans.	Fletcher, Thomas William, Grappenhall, Warrington
June 7, 1894		Flintoff, Robert J. Huxby, Crumpsall-lane, Crumpsall, Manchester
Feb. 18, 1892		Floris, Robert Brooke, Church-house, West Hanningfield, near Chelmsford
Dec. 5, 1895		Foakes, Jervis E., Medical School, Caxton-street, Westminster
Dec. 6, 1894		Fogg, C. A., 39, Park-road, Bolton
June 16, 1859		Fogg, Thomas, 6, Clarendon-gardens, Maida-vale, W.
Dec. 5, 1883		Foggie, John, University College, Dundee
May 7, 1885		Follows, Harold, 39, Meadow-street, Moss-side, Manchester
Feb. 21, 1853		Foord, George, Royal Mint, Melbourne, Australia
Dec. 6, 1894		Forbes, D. G., The Post Office, Kalgoorlie, West Australia
Nov. 19, 1874		Forbes, James, jun., 70, Gracechurch-street, E.C.
Dec. 5, 1889		Ford, John S., care of Messrs. W. Younger and Co., Abbey Brewery, Edinburgh
Mar. 4, 1886		Formoy, James Arthur, Cheetham, Grange-road, Sutton
Dec. 7, 1893		Forrester, Alexander M., Laboratory, Port Dundas Chemical Works, 20, Canal Bank, Glasgow
Dec. 15, 1892	Trans.	Forster, Martin Onslow, Ph.D., Royal College of Science, South Kensington, S.W.
Feb. 2, 1888		Forsyth, W. Cay, St. Andrew, 46, Queen's-road, Leytonstone
Mar. 3, 1856	Trans.	Foster, G. C., F.R.S., 18, Daleham-gardens, Hampstead, N.W.
May 16, 1895		Foster, H. Irving, The Elms, Anlaby-road, Hull
April 6, 1865		Foster, Dr. M., F.R.S., Trinity College, Cambridge
April 4, 1872		Foster, Reginald Le Neve, Harrytown Hall, Bredbury, near Stockport
May 7, 1891	Trans.	Fowler, Gilbert J., M.Sc., 110, Flixton-road, Urmston, Manchester
Mar. 16, 1882		Fowler, William, M.Sc., 1, Grace-terrace, Sunderland
Dec. 5, 1895		Fox, Stanley, 23, South-road, Faversham
June 19, 1884		Foye, Martin Hugh, M.B., C.M.,
Dec. 18, 1879		Francis, Edward, Ivey Bank, Park Valley, Nottingham
Nov. 6, 1873		Francis, G. Bult, 38, Southwark-street, S.E.
Nov. 7, 1842	Trans.	Francis, William, Ph.D., F.L.S., Manor-house, Richmond, Surrey, and Red Lion-court, Fleet-street, E.C.

Date of Election.

Dec. 20, 1847	Trans.	Frankland, Sir Edward, K.C.B., D.C.L., F.R.S., The Yews, Reigate-hill, Reigate
June 16, 1881		Frankland, Henry, Streonshalk, The Crescent, Linthorpe, Middlesbro'
Dec. 2, 1880	Trans.	Frankland, Percy Faraday, Ph.D., F.R.S., Mason College, Birmingham
Mar. 21, 1867		Fraser, Angus, M.D., 232, Union-street, Aberdeen
May 5, 1892		Fraser, James C., Mercantile-chas., Victoria-square, Adelaide, S.A.
May 7, 1885		Freear, Harry M., Hedgefield, Harpenden, Herts
June 16, 1887		Freeman, Frederick W., 7, Park Hall-place, East Finchley
April 4, 1889		Freestone, Joseph T., 1, Alexander-terrace, Rock Ferry, Cheshire
Dec. 15, 1892		French, William, Highfield, 135, Walmersley-road, Bury, Lancs.
April 4, 1889	Trans.	Frew, William, Well Park Brewery, Glasgow
Feb. 2, 1871	Trans.	Friswell, R. J., 115, Darenth-road, Stamford Hill, N.
Dec. 18, 1884		Frost, Joe, Moldgreen, Huddersfield
Nov. 20, 1890		Frost, Robert, B.Sc., 53, Victoria-road, Kensington, W.
April 15, 1880		Fryer, Alfred Cooper, Ph.D., M.A., 13, Eaton-erescent, Clifton, Bristol
May 16, 1895		Fuerst, A. F., Ph.D., 23, Marlborough-road, N.W.
Dec. 3, 1891		Fulcher, Lionel William, B.Sc., South Kensington Museum, S.W., and 56, Buckleigh-road, Streatham Common, S.W.
Feb. 20, 1896		Fuller, C. J. P., Mona House, Horwich, Lancs.
Feb. 16, 1893		Fuller, Frederick George, 85, Shooters-hill-road, Blackheath, S.E.
Dec. 2, 1886		Fuller, John, Rookwood, Montpelier-road, Ealing, W.
Mar. 1, 1883		Fulton, H. B., 33, St. Dunstan's-road, West Kensington, W.
May 3, 1894		Gabb, George Hugh, 43, Charlotte-street, Fitzroy-square, W.
Feb. 18, 1892		Gailleton, Alfred T., Tulloch House, Perth, N.B.
April 19, 1866		Gale, James, Ph.D., M.A., F.G.S., 169, Adelaide-road, South Hampstead
Mar. 4, 1875		Galton, Douglas, Sir, K.C.B., F.R.S., 12, Chester-street, Grosvenor-place, W., and Himbleton Manor, Droitwich
Mar. 17, 1851		Gamble, Sir David, Bart., C.B., Windlehurst, St. Helens, Lancashire
April 6, 1876		Gamble, J. C., St. Helens, Lancashire
Dec. 6, 1883	Proc.	Garbutt, Llewellyn, M.A., 10, College-street, Winchester
Mar. 15, 1888		Gardiner, James H., 59, Wroughton-road, Balham, S.W.
Feb. 21, 1895		Gardner, H. Edward, B.Sc., The College, Epsom, Surrey
May 4, 1893	Trans.	Gardner, J. Addyman, M.A., Chemical Department, St. George's Hospital, S.W.
Dec. 5, 1896		Gardner, James, 80, Heaton-terrace, Rhodes, near Manchester
Nov. 15, 1888		Gardner, Walter M., Technical College, and Fairmount, Munningham, Bradford
Dec. 7, 1893	Trans.	Garnett, Henry, 38, Parolles-road, Upper Holloway, N.W.

Date of Election.

Jan. 17, 1889		Garrett, Frederic Chas., M.Sc., Durham College of Science, Newcastle
Dec. 2, 1880		Garrod, A. E., M.D., 9 Chandos Street, Cavendish-square, W.
April 21, 1898		Garside, A. L. H., B.Sc., The Laboratory, Lawes Chemical Manure Co., Ltd., Barking Creek, Essex
April 17, 1884		Gaskell, Joseph, 71, Haworth-buildings, Cross-street, Manchester
Jan. 18, 1847		Gatty, F. A., Bannister Hall Works, near Preston, Lancashire
Nov. 4, 1875		Gee, T. Ernest, F.R.C.P., 67, Westbourne-park-road, W.
Mar. 3, 1887		Geisler, Joseph F., Ph.C., Mercantile Exchange Buildings, Hudson and Harrison-streets, New York
May 7, 1885		Gemmell, George Harrison, 4, Lindsay-place, Edinburgh
April 17, 1879		Gent, William Thomas, Misterton, Gainsborough
Dec. 3, 1896		George, George, Regent-street, Kingswood, near Bristol
Feb. 21, 1889		Gerland, Conrad, M.Sc., Ph.D., Municipal Technical Laboratory, Blackburn; and Accrington
Dec. 3, 1891		German, George, Junr., Huntingdon House, Ashby-de-la-Zouch
Feb. 21, 1895		Gerrans, H. Tresawna, M.A., 20, St. John Street, Oxford
Nov. 4, 1875		Gerrard, A. W., 35, Queen's-road, Wimbledon
Dec. 6, 1888		Geyzel, John Lawrence Van, Surgeon-Major, Chemical Examiner, Medical College, Madras, East India
June 7, 1894		Ghasvala, B. E., Grant Medical College, Byculla, Bombay
Feb. 6, 1890		Gibbes, Cuthbert C., M.D., M.C., L.R.C.P., D.P.H.,
Mar. 4, 1897		Gibbons, J. L., The Higher Grade School, Blyth, Northumberland
Mar. 5, 1885		Gibson, Adam, c/o Messrs. Pinkerton, Gibson & Co., Thistle-street-lane East, Edinburgh
June 16, 1892	Trans.	Gibson, John, Ph.D., F.R.S.E., F.I.C., Heriot-Watt College, Edinburgh
June 21, 1888		Gibson, W. Humphrey, 122, King's-road, Brighton
May 16, 1895		Gilbard, J. F. H., 8, Glaskin-villas, Lea Bridge-road, N.E.
May 18, 1841	Trans.	Gilbert, Sir Joseph Henry, Ph.D., F.R.S., F.L.S., Harpenden, St. Albans
Mar. 4, 1897		Gilbody, A. W., M.Sc., Ph.D., Owens College, Manchester
Feb. 17, 1898		Gilderdale, Frederick, 1, Havelock-street, Newcastle-on-Tyne
Feb. 1, 1883		Gill, E. Clarendon, Ivy Dene, Christchurch, Hants
Mar. 17, 1881		Gill, E. J. G., 29, King Henry's-road, South Hampstead, N.W.
April 19, 1888		Gill, John, Gwealhellis, Helston, Cornwall
Feb. 17, 1898	Proc.	Gilles, W. S., Bradford-street, Bocking, Braintree, Essex
April 6, 1865		Gillman, A. W.,
Dec. 3, 1885		Girdwood, Gilbert P., M.D., 54, Beaver Hall Hill, Montreal
May 6, 1897		Girtin, Thomas, B.A., 125a, Highbury New Park, N.
Dec. 18, 1848	Trans.	Gladstone, John Hall, Ph.D., F.R.S., 17, Pembroke-square, Hyde Park, W.
Feb. 17, 1898		Glaister, John, Prof., M.D., 4, Grafton-place, Grafton-square, Edinburgh

Date of Election.		
Mar. 4, 1886		Glenfield, Francis W. S., 27, Gloucester-gardens, Hyde Park-square, W.
Jan. 18, 1872		Glover, George Thomas, Corbys, Hoylake, Cheshire
May 16, 1895		Goddard, Wm., 11, Granville-road, Middlesbro'
Feb. 21, 1895		Goldfinch, George, Hendon, N.W.
April 4, 1878		Goldschmidt, S. A., Ph.D., care of Columbia Chemical Works, 4, to 51, Sedgwick-street, Brooklyn, New York
May 16, 1889		Goldsmith, Byron B., 19, East 74th-street, New York City, U.S.A.
June 18, 1896		Goldstand, L. F., Nowo-Zielna, 48, Warsaw, Russian Poland
June 17, 1897		Gomess, A. F. Bilderbeck, M.R.C.S., 33, Drayton-gardens, South Kensington
Dec. 15, 1892		Goodall, Walter, Alma House, Pudsey, near Leeds
Dec. 4, 1890		Goodwin, Thomas S., Prof. Veterinary College, Buccleuch-street, Glasgow
May 7, 1896		Goodwin, William, c/o Miss. Stewart, 5, Doune Quadrant, Kelvin-side, Glasgow
Nov. 20, 1890		Gordon, Colin, Storer's Wharf, Cubitt Town, E.
April 21, 1887	Proc.	Gordon, Hugh, M.A. Oxon., The Cottage, Torkington, Cheshire
Mar. 4, 1875		Gordon, J. G., Queen Anne's Mansions, Westminster, S.W.
Mar. 6, 1890		Gossling, Frank, B.Sc., Caudebec, Park Side, Hampton Wick
Feb. 1, 1883		Gothard, Frederic, Bearwood House, Burton-on-Trent
Jan. 17, 1889	Trans.	Gott, B. S., M.A., The Guildhall, Westminster, S.W.
Mar. 4, 1897		Gough, H. W., B.A., 73, Billing-road, Northampton
Feb. 6, 1879		Gough, Thomas, Rev., B.Sc., (Lond.), King Edward's School, Retford, Notts.
Mar. 4, 1897	Trans.	Goulding, Ernest, 18, Mercers-road, Holloway, N.
June 16, 1887		Gover, Herbert J., 29, Piccadilly, Hanley, Staffordshire
Jan. 17, 1889		Gow, Robert J., Ivy Lea, Hough Green, near Widnes
May 4, 1893		Gower, Alfred Roland, 18, West View-road, Barrow-in-Furness
Feb. 2, 1871	Trans.	Gowland, William, 13, Russell-road, Kensington, W.
Feb. 3, 1887	Trans.	Goyder, George A., Hawkins-road, Medindie, Adelaide, South Australia
June 19, 1884		Grace, W. F., 54, York-road, Hove, Brighton, and the Lake View and Boulder Junction Gold Mines, Limited, Kalgoolie, W. Australia
Feb. 15, 1894		Grafton, Walter, 54, Byron-avenue East, East Ham, Essex
April 15, 1880	Trans.	Graham, C. Colborne, Highmoor, Benrhydding-road, Ilkley, Yorks
May 1, 1862		Graham, Charles, D.Sc., 23, Euston-buildings, Gower-street Station, N.W.
Dec. 5, 1895	Trans.	Graham, Edward, B.Sc., The Grange, Woodlands-road, Redhill
Feb. 6, 1890		Grant, James, 9, Arthur-street, Prestwich, near Manchester
May 16, 1895	Trans.	Grant, P. H., 94, Copleston-road, Denmark-hill, S.E.
June 16, 1887		Gravill, Edward D., F.R.M.S., 42, Walmsley-street, Hull

Date of Election.		
Dec. 7, 1882		Gray, George, Canterbury Agricultural College, Lincoln, New Zealand
Dec. 15, 1892	Trans.	Gray, Thomas, Andersonian-buildings, 204, George-street, Glasgow
May 16, 1895		Greaves, W. A., Grammar School, Newark
Dec. 4, 1890		Green, Alfred H., Oaklands, Lowton St Mary's, Newton-le-Willows
Feb. 5, 1885	Trans.	Green, Arthur George, 13, King's-drive, Heaton Moor, near Stockport
June 15, 1893		Green, Arthur Henry, 207, Lloyd-street, Greenheys, Manchester
June 16, 1887		Green, John Edward, F.I.C., A.R.S.M., 1, Queen's-road, Urms-ton, Manchester
Dec. 5, 1878		Green, Herbert, Hayle Mill, Maidstone
Dec. 5, 1878		Green, Lawrence, Lower Tovil, Maidstone
April 2, 1874	Trans.	Greenaway, Alfred John, F.I.C., 39, Frogual, Hampstead, N.W.
Dec. 3, 1885		Greene, William H., M.D., 204, North 36-street, Philadelphia
June 4, 1885		Greenway, Thomas J., 8th Avenue, East Adelaide, South Australia
May 15, 1873		Greenwood, William Henry, Birmingham Small Arms and Metal Co., Adderley Park Works, Birmingham
Dec. 6, 1894	Proc.	Greeves, A., 25, Balmuir-gardens, Putney, S.W.
June 18, 1891		Gregory, Alfred John, M.D., B.Sc., Colonial Secretary's Office, Cape Town
May 7, 1885		Gregory, G. M., Ghazipur, N.W.P., India
Mar. 1, 1883		Grenfell, Claud, M.A.,
Mar. 5, 1874		Greville, Henry Leicester, Diersheim, Churchfields, Woodford
Feb. 20, 1896		Grice, W. T., 9, Dalhousie-square, Calcutta
Dec. 7, 1893		Grieve, William Hatten, 226, Friern-road, East Dulwich, S.E.
Feb. 2, 1888		Griffith, D. Agnew, c/o Messrs. Mitchell and Co., 27, King-street, Liverpool
June 16, 1859		Griffith, George, M.A., College-road, Harrow
Dec. 15, 1881	Trans.	Griffiths, Arthur Bower, Ph.D., F.R.S.E., 12, Knowle-road, Brixton, S.E.
April 17, 1879		Griffiths, Thomas, The Cedars, Clapham Common, S.W.
Feb. 21, 1895		Grime, Herbert, 51, Chiswick-street, Carlisle
Feb. 19, 1874	Trans.	Grimshaw, Harry, Sunnyside, North-road, Clayton, Manchester
April 15, 1880		Grimwood, Robert, London County Council, Chemical and Gas Department, 40, Craven-street, W.C.
May 4, 1893		Grimwood, Robert George, 41, Lady Maragret-road, St. John's College Park, N.W.
Dec. 5, 1889		Gripper, Harold, 2, Heald-place, Rusholme, Manchester
Dec. 15, 1892		Gronow, William Thomas, Port Pirie Smelting Works, Port Pirie, South Australia
Dec. 5, 1895		Grossman, E. H., 12, Alfred-place, West, S.W.
April 6, 1871	Trans.	Groves, Charles Edward, F.R.S., Kennington-green, S.E., and Guy's Hospital, S.E.

Date of Election.

June 17, 1897		Grundey, F. R., B.Sc., 20, Derby-road, Douglas, Isle of Man
Mar. 4, 1897		Guest, E. G., M.A., The Grammar School, Kirkham Lancs.
May 16, 1895		Gunn, A., c/o Messrs. Lorimer and Co., Britannia-row, Islington, N.
April 21, 1898		Guthrie, Alexander, B.Sc., The Cottage, Bocking, Braintree, Essex
Dec. 6, 1888	Trans.	Guthrie, Frederick Bickell, Chemical Laboratory, The University, New South Wales
Dec. 2, 1897		Guttman, Oscar, 12, Mark-lane, E.C.
Nov. 4, 1875		Guyer, James Brett, Wrentham, Higher Erith-road, Torquay
May 6, 1897		Guyer, R. Glode, c/o Messrs. Duncan, Flockhart, and Co., 104, South Bank, Canongate, Edinburgh
June 4, 1874		Habirshaw, W. M., Glenwood Works, Yonkers, New York, U.S.A.
Feb. 7, 1878		Hadkinson, John
June 7, 1894		Hadley, Arthur, United Breweries, Carmarthen
Dec. 7, 1893		Hadley, Henry Edwin, The School of Science, Kidderminster
Dec. 16, 1886	Trans.	Haga, T., Pestalozzistrasse 105, Charlottenberg, bei Berlin
June 16, 1881		Hailes, Alfred James de, 15, Red Lion-square, W.C.
Dec. 15, 1892		Haines, Walter S., Prof., c/o Rush Med. College, Chicago, U.S.A.
Jan. 20, 1876	Trans.	Hake, H. Wilson, Ph.D., Westminster Hospital Medical School, Caxton-street, S.W.
Dec. 7, 1893		Hale, Henry Ormsby, Oundle School, Northamptonshire
Dec. 3, 1891		Hall, A. D., S.E., Agricultural College, Wye, Kent
Jan. 17, 1889		Hall, Allan T., Ivy Cottage, Willerby, near Hull
Dec. 3, 1891		Hall, Archibald, 34, Bishopsgate-street, E.C.
Jan. 17, 1889	Trans.	Hall, John A., Victoria Chemical Works, Victoria, B.C.
June 1, 1876		Hall, Samuel, East London Soap Works, Bow
Feb. 16, 1893		Haller, Albin, 14, Rue de Metz, Nancy, France
May 16, 1895		Haller, H. Loft, 26, Scale-lane, Hull
May 20, 1886		Halliburton, William Dobinson, M.D. Lond., B.Sc., F.R.S., 9, Ridgmount-gardens, Gower-street, W.C.
June 17, 1897		Halliwell, Edward, c/o West Riding Rivers Board, Wakefield
Feb. 3, 1859		Hambly, C. H. Burbridge "Fairley," Weston, Bath
April 17, 1890	Trans.	Hambly, Frederick J., c/o The Electric Reduction Co., Buckingham, Que. Canada
June 7, 1888	Trans.	Hamilton, James C., Arneliffe, Arnside, viâ Carnforth
Dec. 2, 1897		Hamilton, Robert, 11, Ibrox-place, Glasgow
Feb. 15, 1894		Hamilton, Robert, Leeds Steel Works, Leeds
May 6, 1875	Trans.	Hamlet W. M. Government Laboratory, Macquarie-street, Sydney, N.S.W.
Jan. 18, 1877		Hampton, William, 38, Lichfield-street, Hanley

Date of Election.

Feb. 7, 1857		Hanbury, Cornelius, Plough-court, Lombard-street, E.C., and Dynevor House, Richmond, Surrey
June 15, 1893		Hancock, Ernest Albert, Government Analyst, St. Kitts, Leeward Islands, W.I.
Dec. 5, 1895	Trans.	Hanes, E. S., 108, Alexandra-road, N.W.
June 18, 1896		Hanger, R. H., Riverslea, Stoneferry, Hull
Mar. 7, 1872	Trans.	Hannay, James Ballantine, Cove Castle, Loch Long, N.B., and Whitehall Club, S.W.
Feb. 21, 1889		Hanson, Alfred Miall, The Whalley Abbey Printing Co., Ltd., Whalley, near Blackburn
Feb. 21, 1895		Hanson, Weldon, 159, Albert-road, Middlesbrough
June 17, 1897		Harbord, F. W., Egham, Surrey
Feb. 3, 1859	Trans.	Harcourt, A. G. Vernon, M.A., D.C.L., LL.D., F.R.S., Cowley, Grange, Oxford
April 16, 1863		Harcourt, L. F., Vernon, M.A., Fairholme, Weybridge
Mar. 17, 1887	Proc.	Harden, Arthur, M.Sc., Ph.D., 20, Kensington-crescent, W.
May 7, 1885		Hards, William Benjamin, B.A. Lond., Science and Art Department, South Kensington, S.W.
Dec. 15, 1892		Hardy, James G., 5, Dalkeith Avenue, Dumbreck, Glasgow
Dec. 2, 1897		Harger, John, B.Sc., Ph.D., The Nook, St. James's Mount, Liverpool
Jan. 20, 1876		Hargreaves, James, Peel House-lane, Farnworth, near Widnes, Lancashire
June 19, 1884		Hargreaves, John, Widnes, Lancashire
Dec. 16, 1875		Harkness, William, 1, St. Mary's-road, Canonbury, N.
June 1, 1876		Harland, R. H., 37, Lombard-street, E.C.
Feb. 7, 1878		Harland, William Dugdale, 48, King-street, Manchester
Mar. 4, 1897		Harley, Vaughan, M.D., 25, Harley-street, W.
Jan. 15, 1874		Harman, F. E., M.R.A.C., c/o Dr. Piggott, 13, Orchard-gardens, Teignmouth, Devon
June 17, 1897		Harman, Harold, Shalmsford, Brixton-hill. S.W.
May 6, 1897		Harrie, H. W., c/o Messrs. Harker, Staggs and Morgan, 15, Lawrence Pountney-lane, E.C.
June 17, 1897		Harrington, B. J., Ph.D., McGill University, Montreal
Dec. 15, 1881		Harrington, William Bury, Leevew, Montenotte, Cork
Feb. 20, 1896		Harrington. Wm., 9, Edgehill, Bransby, Whitehaven
June 18, 1896		Harris, F. W., Public Analyst's Office, Burnley
Feb. 21, 1884		Harris, Frank W., Laboratory, G.W. Ry., Swindon, Wilts
Dec. 7, 1893		Harris, Harold, c/o Messrs. Dalgety, and Co., Ltd., Sydney, N.S.W.
Feb. 21, 1895		Harris, Harry, The Hall Mines Smelter, Nelson, B.C.
Dec. 17, 1874		Harris, Henry Penley, 15, Coverdale-road, Shepherd's Bush, W.
June 7, 1894		Harris, Sydney Walters, 15, Lansdowne-terrace, Walters-road, Swansea

Date of Election.

Feb. 7, 1878		Harris, Thomas Frederick, B.Sc., Bromley Lodge, Bromley Kent
Feb. 21, 1895		Harris, Walter, B.A., Ph.D., Campbell College, Belfast
May 17, 1888		Harrison, Albert, 72, Windsor-road, Forest Gate
Dec. 5, 1895		Harrison, C. E., B.A., Abbey View, Potters-bar, N., and St. George's-house, Eastcheap
Feb. 15, 1894	Trans.	Harrison, Edward Frank, 51, Holly-avenue, Newcastle
June 21, 1883		Harrison, Hugh Erat, B.Sc., 2, Park-place, Regent's Park, N.W. and Faraday-house, Charing Cross-road
May 17, 1888		Harrison, J. Burchmere, Government Laboratory, British Guiana
Feb. 19, 1891		Harrold, Frederick W., 18, Maddox-street, W.
Feb. 17, 1876	Trans.	Harrow, G. H., Ph.D., Messrs. Allsopp, and Sons' Brewery, Burton-on-Trent
Mar. 4, 1886		Hart, Bertram Harvey, The Elms, Old Charlton, Kent, S.E.
Jan. 21, 1869	Trans.	Hart, F. W., Holly House, 96, Stoke Newington-road, N.
May 7, 1891		Hart, William Beaumont, Gransmoor-avenue, Fairfield, near Manchester
Mar. 16, 1882		Hartley, Arthur, The Haslar-street, Brewery, Gosport
Mar. 4, 1897		Hartley, E. G. J., B.A., Wheaton-Aston Hall, Stafford
Mar. 4, 1897		Hartley, Thomas, Patwell-street, Bruton, Somerset
Dec. 20, 1866	Trans.	Hartley, Walter Noel, Prof., F.R.S., Royal College of Science, Stephen's-green, Dublin; and 36, Waterloo-road, Dublin
Feb. 6, 1890	Proc.	Hartog, P. J., B.Sc., Owens College, Manchester; and 22, Brondesbury-villas, London, N.W.
Dec. 3, 1885		Harvey, Ernest Wm., A.R.S.M., 20, Malwood-road, Balham, S.W.
Feb. 17, 1881		Harvey, Sidney, Canterbury
Feb. 15, 1894		Harvey, W. Pellew, Assay and Mining Office, Vancouver, B.C.
May 6, 1875		Hastings, Henry Mitchell, 54, Edith-road, The Cedars, West Kensington
Feb. 21, 1894		Hatfield, J. Adams, 89, Bridge-street, Wednesbury
Feb. 18, 1892		Hatton, William Percy, c/o W. R. Hatton and Sons, Wormwood Scrubs
Dec. 2, 1880		Hawkes, Alfred E., M.D. Bruss., L.R.C.P. Edin., 22, Abercromby-square, Liverpool
May 7, 1896		Hawkins, Edgar, M.D., M.A., M.S., Dispensary, Dudley
Feb. 2, 1888		Hawkins, Lewis Walter, 20, Norton Folgate, E.
Dec. 6, 1894	Trans.	Haworth, E., M.Sc., 6, Stanley-villas, Runcorn, Cheshire
Mar. 3, 1887		Hay, Alexander, 93, Culford-road, N.
Feb. 15, 1894		Hayward, Edward Stanley, c/o Mrs. Sauders, 109, High-street, Crediton, Devon
Dec. 1, 1887		Head, C. James, F.I.C., 117, Bedford-road, Clapham, S.W.
Dec. 15, 1881		Head, Harold Ellershaw, 5, Ilchester-mansions, Kensington, W.
Mar. 16, 1876		Head, Jeremiah, 47, Victoria-street, Westminster, S.W.

Date of Election.

Feb. 16, 1893		Heath, Arthur John, 1, Grove-villas, Redland, Bristol, and Monkton Combe School, Bath
Dec. 3, 1891		Heath, John William, 33, Upper Gloucester-place, W.
Nov. 2, 1876		Hehner, Otto, 11, Billiter-square, E.C.
Dec. 5, 1889		Helbing, H. B., 63, Queen Victoria-street, E.C.
Dec. 4, 1890	Proc.	Heller, William M., B.Sc., Municipal Technical School, Suffolk-street, Birmingham
June 3, 1875		Hellon, Robert, Ph.D., Seascale, viâ Carnforth
Jan. 18, 1872		Helm, Henry James, Simonstone, 27, Hammelton-road, Bromley, Kent
Dec. 6, 1894		Helms, Albert, M.A., Ph.D., 8, Bridge-street, Sydney, N.S.W.
Feb. 20, 1896		Helps, J. W., 3, Tavistock-road, Croydon
Feb. 5, 1885	Trans.	Henderson, George G., Prof., M.A., D.Sc., F.I.C., the Technical College, 204, George-street, Glasgow
Dec. 5, 1895	Trans.	Henderson, James, B.Sc., Ph.D., c/o The American Brewing Academy, 294, South Water-street, Chicago Ill., U.S.A.
Feb. 18, 1892		Hendrick, James, B.Sc., F.I.C., The University, Aberdeen
Feb. 21, 1853		Hepburn, J. G., LL.B., Dartford, Kent
Mar. 4, 1897		Heppenstall, Charles, Victoria-road, Stanford-le-Hope, Essex
June 18, 1885		Hepworth, T. Cradock, 10, Lysias-road, Balham-hill, S.W.
Dec. 5, 1895		Heriot, T. H. P., 23, Wolseley-road, Crouch End, N.
Feb. 16, 1871		Herman, Douglas, Eccleston-park, Prescott
June 15, 1876	Trans.	Heron, John, 110, Fenchurch-street, E.C.
Dec. 7, 1893		Hesketh, William, 16, New Market-street, Blackburn
May 5, 1892	Trans.	Hewitt, John Theodore, M.A., D.Sc., Ph.D., 65, Silverdale, Sydenham
Feb. 18, 1892		Hewlett, John C., 40, Charlotte-street, Great Eastern-street, London, E.C.
June 21, 1883	Trans.	Heycock, Charles T., M.A., F.R.S., 24, Fitzwilliam-street, Cambridge
Dec. 1, 1864		Heywood, Henry, Witla Court, near Cardiff
Dec. 1, 1887		Heywood, J. Garnett, 127, Sutherland-avenue, Maida Vale, W.
Feb. 6, 1890		Heywood, Joseph H., Sparth Cottage, Manchester-road, Rochdale
April 3, 1848		Heywood, J. S. C., 19, Inverness-terrace, Kensington-gardens, W.
June 1, 1876	Trans.	Hibbert, Walter, 101, Goldhurst-terrace East, South Hampstead, N.W.
June 7, 1894		Hichens, J. H., M.A., F.G.S., The School House, Wolverhampton
Mar. 17, 1881		Hiddingh, Michael, Newlands, near Capetown
Dec. 6, 1894		Higgs, M. S., Eastleigh Gold Mines, Klerksdorp, S.A.R.
Mar. 16, 1882		Hill, Alexander
Dec. 16, 1858		Hill, Alfred, M.D., F.I.C., F.R.S.E., Medical Officer of Health, The Council House, Birmingham

Date of Election.		
Dec. 3, 1896	Proc.	Hill, A. Croft, B.A., Davy-Faraday Research Laboratory, Albe-marle-street, W.
Dec. 3, 1896		Hill, C. A., Hawthorns, South-road, Clapham Park, S.W.
June 18, 1896		Hill, E. G., Prof., B.A., Muir College, Allahabad
May 6, 1897		Hill, Sydney, 11, Salisbury-street, Hull
Feb. 15, 1894		Hills, Edmond Herbert, Capt. R.E., Darland House, Chatham
Mar. 5, 1892		Hills, Harold F., 147, Bow-road, E.C.
Feb. 17, 1898		Hills, T. H., 6, Eliot Park, Blackheath, S.E.
May 15, 1873		Hills, Walter, 225, Oxford-street, W.
Dec. 3, 1896		Hinchley, J. W.,
May 5, 1892		Hinnell, Henry Leonard, 41, Corporation-street, Manchester
May 3, 1894		Hirsch, C. T. W., M.D., Charlinch, Rectory-road, Woolwich, S.E.
Jan. 20, 1870		Hislop, G. R., Gasworks, Blackstoun-road, Paisley
Nov. 18, 1886		Hislop, Lawrence, 33, Slatey-road, Birkenhead
April 21, 1898		Hislop, Lawrence, Gasworks, Uddingston, Glasgow
June 21, 1883		Hobbs, Bedo, The Brewery, High-street, Maidenhead
Dec. 18, 1884		Hodges, Herbert J., Dagmar, Napier-avenue, Fulham
April 15, 1844	Trans.	Hodges, John F., Prof., M.D., F.I.C., J.P., Queen's College, Belfast, and Sandringham, Malone-road, Belfast
Nov. 16, 1882	Trans.	Hodgkin, John, F.L.S., F.I.C., 12, Dynevor-road, Richmond-on-Thames
Dec. 18, 1879	Trans.	Hodgkinson, W. R. Eaton, Prof., Ph.D., F.R.S.E., 18, Glenluce-road, Blackheath, S.E.
April 15, 1886		Hodgson, Christopher, High House, Eppleby, Darlington
April 21, 1898		Hodgson, H. P., Caldew Bank, Cummersdale, near Carlisle
April 17, 1873		Hodgson, H. Tylston,
Dec. 6, 1894		Hogg, A. F., M.A., 13, Victoria-road, Darlington
May 7, 1885		Hogg, Edward Grindle, 1, Southwick-street, Hyde Park-square, W.
Mar. 1, 1883		Hogg, W. Douglas, M.D., 62, Champs Elysées, Paris
June 11, 1876		Holcroft, Harold, M.A., Parkdale, Wolverhampton
Dec. 3, 1885		Holgate, Thomas, 12, Hyde Park-road, Halifax
Mar. 16, 1876		Holland, Philip, 22, Taviton-street, Gordon-square, W.
Dec. 2, 1880		Holliday, Robert, c/o Messrs. Read, Holliday and Sons, Limited, Huddersfield
June 18, 1891		Holloman, Frederick R., c/o Messrs. Tennant's Agency, San Fernando, Trinidad, B.W.I.
Mar. 4, 1886		Holloway, George Thomas, 57 and 58, Chancery-lane, W.C.
Dec. 5, 1895		Holme, A. E., M.A., The Wheelwright Grammar School, Dewsbury
Mar. 4, 1897		Holmes, John, Crewe Villa, Putney Bridge-road, S.W.
Dec. 2, 1886		Holmes, John Winder, Rayton-xi-towns, Shropshire
Dec. 7, 1893		Holthouse, H. B., 12, Melton-grove, West Bridgford, Notts.

Date of Election.		
May 4, 1865	Trans.	Holzmann, M., Ph. D., Marlborough-house, S. W.
Feb. 17, 1898		Homfray, David, B.Sc., 6, Dartmouth-row, Greenwich, S.E.
Feb. 7, 1878		Hooker, A. H., Board of Health, Cairo, Egypt
Dec. 15, 1892		Hooker, Samuel C., The Franklin Sugar Refinery Co., 701, Front-street, Philadelphia
Mar. 1, 1883	Proc.	Hooper, David, Curator, Economic and Art Section, Indian Museum, Calcutta
May 17, 1888		Hooper, E. Grant, 16, Royal-avenue, Chelsea, S. W.
Feb. 19, 1891		Hooper, Ernest F., Wear Fuel Works, South Dock, Sunderland
Feb. 15, 1894		Hornby, R., B.A., Marsh Parade, Newcastle, Staffordshire
Dec. 15, 1892		Horsfall, John, 4, Grange-avenue, Rawtenstall, Manchester
Dec. 2, 1897		Horseman, J. W., County School, Bedford
Dec. 15, 1892		Horwill, Edgar E. C., 19, Devereux-road, New Wandsworth, S. W.
Mar. 4, 1886		Hoskins, Arthur Percy, 25, Cromwell-road, Belfast
Dec. 7, 1882		Hotblack, Herbert A., Cannon Brewery, Brighton
Feb. 16, 1871		Houlder, W. W., 10, Ossulton-villas, Southall-green, Southall
Mar. 17, 1887	Trans.	Houlding, William, B.Sc., Gilmerton, Cressington-park, Liverpool
Feb. 20, 1896		Howard, Albert, A, Newcourt, St. John's College, Cambridge
Dec. 7, 1882		Howard, Alfred G., Burnt House, Chigwell, Essex
Feb. 18, 1869		Howard, Alfred Kingsby, Bryntirion, Rhyl, N. Wales
Nov. 3, 1870		Howard, David, Devon House, Buckhurst Hill, Essex
April 21, 1887		Howard, D. Lloyd, jun., Little Friday Hill, Chingford, Essex
June 20, 1889		Howard, George William, Calverley, Tunbridge Wells
Mar. 4, 1875		Howard, Thomas, 50, Ellington-street, Liverpool-road, N.
Dec. 7, 1882		Howe, J. Lewis, M.D., Ph.D., Prof. of Chem., Washington, and Lee University, Lexington, Va., U.S.A.
Feb. 19, 1880		Howell, Reginald, 95A, Southwark-street, S.E.
Jan. 20, 1876	Trans.	Howie, W. L., Monton Lodge, Monton, Eccles, Lancashire
April 4, 1889		Hoyle, Richard Ashworth, 11, Market-square, Lytham, Lancs.
April 4, 1889		Hoyles, Henry Richardson, c/o Messrs. Treacher and Co., Byculla, Bombay, and Fern-place, 142, Upperthorpe, Sheffield
Mar. 2, 1871		Hudleston, W. H., M.A.
Feb. 21, 1878		Hudson, William, B.Sc. (Lond.), The Lilies, Twickenham
Feb. 15, 1894		Hughes, Frank, 78, Duke-street, Chelmsford
June 17, 1880		Hughes, George Henry, Analytical Laboratory, Barbadoes, West Indies; and 155, Fenchurch-street, E.C.
Dec. 17, 1868		Hughes, John, Analytical Laboratory, 79, Mark-lane, E.C.
June 18, 1896		Hughes, J. A., 1, Bridewell-street, Bristol
June 4, 1885		Hughes, T. Vaughan, Princes Chambers, 6, Corporation-street, Birmingham
Nov. 16, 1882		Hughes, Thomas, Borough Analyst, West Wharf, Cardiff Laboratory, 31, London-square, Cardiff

Date of Election.

Nov. 20, 1884		Hulme, James,
April 19, 1883		Humphrys, Norton H., 4, The Paragon, Wilton-road, Salisbury
Dec. 18, 1879	Trans.	Hummel, J. J., The Yorkshire College, Leeds
Dec. 7, 1893		Hunt, Bertram, 216, Sansome-street, San Francisco, California, U.S.A.
Mar. 18, 1869		Hunt, Charles, Birmingham Gas Light Works, Windsor-street, Birmingham
Feb. 1, 1883		Hunter, John, 29, Chambers-street, Edinburgh
Dec. 3, 1885		Hunter, Matthew, M.A., Oxon, Rangoon College, Lower Burmah
April 4, 1878		Huntington, A. K., Prof., Metallurgical Laboratory, King's College, W.C.
Feb. 16, 1893		Huntly, George Nevill, 56, Sheen-road, Richmond
Dec. 3, 1885		Hurst, George H., 22, Blackfriars-street, Salford
Mar. 21, 1861		Huskisson, H. O., 5, Gordon-square, London, W.C.
Feb. 15, 1894		Hutchinson, Alfred, B.A., B.Sc., Bryn-y-Mer, Saltburn
Feb. 6, 1890	Trans.	Hutchinson, Arthur, M.A., Ph.D., Pembroke College, Cambridge
Jan. 17, 1884		Hutchinson, C. Clark, 8, Cleve-road, Hampstead, N.W.
Nov. 19, 1885		Hyatt, W. H.,
Mar. 4, 1897		Ibbotson, F., B.Sc., 9, Melbourn-road, Spring-vale, Sheffield
April 19, 1888		Idris, Thomas Howell Williams, Pratt-street, Camden Town, N.W.
Feb. 7, 1867		Ince, Joseph, 11, St. Stephen's-avenue, Shepherd's-bush, W.
Dec. 15, 1892	Trans.	Ince, Walter H., Ph.D., Port of Spain, Trinidad
April 4, 1889	Trans.	Ingle, Herbert, Poole, near Leeds
Mar. 4, 1897		Innes, W. R., Ph.D., M.Sc., Mason College, Birmingham
Dec. 7, 1871		Irvine, Robert, Royston, Granton, near Edinburgh
Dec. 6, 1883		Irwin, Wilfred, 3, Wilton Polygon, Cheetham Hill, Manchester
Dec. 15, 1892		Isaac, John F. V.,
Feb. 16, 1882		Isherwood, Thomas, M.A., LL.D., D.C.L., University School, Southport
Nov. 19, 1885		Ivatt, Albert, B.A., 38, Glisson-road, Cambridge
May 3, 1894		Jackman, Edwin James, 60, Belgrave-road, Ilford
Feb. 1, 1883		Jackson, A. H., B.Sc., The Electrical Engineering School, 358, Collins-street, Melbourne, Australia
Feb. 15, 1894	Proc.	Jackson, David Hamilton, M.A., B.Sc., Ph.D., 37, Leigh-road South, Clifton, Bristol
Dec. 7, 1882		Jackson, Edward, Clovelly, Grove Avenue, Moseley, Birmingham
Dec. 5, 1889		Jackson, Eric H., B.Sc., 42, Whitworth-street, Manchester
Dec. 18, 1884	Trans.	Jackson, Herbert, 3, Amyand Park Gardens, East Twickenham, and King's College, Strand
Dec. 15, 1892		Jackson, John, Llangorse Villa, Serpentine-road, Gold Tops, Newport, Mon.

Date of Election.		
Dec. 6, 1883		Jackson, Robert, 18, Harrington-street, Dublin
Dec. 15, 1881		Jackson, R. Valentine, c/o The Scotch and Irish Oxygen Company, Polmadie, Glasgow
Dec. 15, 1892		Jackson, Samuel, c/o Binney and Co., Madras
June 16, 1887		Jadhava, K. B., Nowasari, Bombay Presidency, India
May 16, 1878	Trans.	Jago, William, F.I.C., Godrevy-house, Wilbury-avenue, Hove, Brighton, and Cornwall-buildings, 35, Queen Victoria-street, E.C.
Dec. 5, 1895		James, Alfred, 56, New Broad-street, E.C.
Feb. 18, 1888		James, Christopher, care of Elliott's Metal Company, Pembrey Copper Works, R.S.O., Burry Port, South Wales
Feb. 7, 1878		Jamieson, Alexander, 5, St. Mark's-crescent, Regent's Park, N.W.
Feb. 6, 1879	Trans.	†Japp, F. R., M.A., LL.D., F.R.S., University, Aberdeen
Nov. 16, 1882		J'Armay, Gustav, Hartford Lodge, Hartford, Cheshire
April 21, 1898		Jee, E. C., B.Sc., 45, Pepys-road, New Cross, S.E.
Feb. 20, 1896		Jeffers, E. H., 21, Moatholme-road, New Wandsworth, S.W.
Feb. 19, 1891	Trans.	Jenkins, Henry Charles, Royal Coll. of Science, S. Kensington, S.W.
May 5, 1892		Jenkins, John H. B., Chemical Laboratory, G.E. Ry. Works, Stratford, E.
May 7, 1896		Jenkins, J. P., 30, St. John's-road, Clifton, Bristol
Feb. 15, 1894		Jenks, R. Leonard, 33, Cautley-avenue, Clapham Common, S.W.
Feb. 15, 1894		Jennison, Francis Herbert, 26, Derby Crescent, Kelvinside, near Glasgow
Mar. 4, 1896	Trans.	Jerdan, D. S., M.A., B.Sc., Owen's College, Manchester
April 21, 1898		Jessop, S. M., 12, Hanson-terrace, Wakefield
April 17, 1879		Jewson, Francis A. B., Homefield, Station-road, Clapham
Feb. 4, 1875		Johnson, David, F.G.S., F.R.M.S., 1, Victoria-road, Clapham Common, S.W.
Dec. 5, 1895		Johnson, F. E., Holly House, Cottingham, Hull
Mar. 4, 1897	Trans.	Johnson, Harold, 5, Boulevard Clovis, Bruxelles
Feb. 1, 1883		Johnson, James Edward, 40, Edmiston-road, Stratford, E.
May 16, 1872		Johnson, John Grove, 41, Cross-street, Finsbury, E.C.
May 20, 1886		Johnson, J. T., 55, South-street, Durham
Mar. 4, 1897		Johnson, Otis C., Prof., 52, Thayer-street, Ann Arbor, Mich., U.S.A.
May 10, 1866		Johnson, Samuel H., The Warren Hill, Loughton, Essex
Feb. 20, 1896		Johnstone, James, Braehead, Parkhill, Rutherglen
Dec. 18, 1884		Johnstone, James D.,
Dec. 15, 1892		Johnstone, William George, c/o Messrs. Warwick's, The Brewery, Newark-on-Trent
May 20, 1886	Proc.	Jones, A. Wentworth, M.A., Oxon., M.R.C.S., L.R.C.P., Headmaster Paddington High School, W., and 7, St. Charles-square, W.

† Longstaff Medallist, 1891.

Date of Election.

April 21, 1898		Jones, Edward, B.Sc., Vine Cottage, Tudor-road, Kingston-on-Thames
May 16, 1895		Jones, E. L., The County School, Milford Haven
April 6, 1871	Trans.	Jones, E. W. T., The Oaklands, Wolverhampton; and 10, Victoria-street, Wolverhampton
Dec. 4, 1873	Trans.	Jones, Francis, F.R.S.E., Beaufort House, Alexandra Park, Manchester
Dec. 6, 1894		Jones, Geo. Cecil, Basingstoke Ironworks, Hants
May 4, 1876	Trans.	Jones, H. Chapman, Royal Coll. of Science, S. Kensington, S.W.
May 4, 1893		Jones, Hedley Gordon,
May 16, 1878		Jones, Henry Williams, Spencer-park, Coventry
May 15, 1890		Jones, John Archyll, B.Sc., 27, Southfield-road, Middlesborough
Feb. 18, 1892	Trans.	Jones, Lionel Manfred, St. Dunstan's College, Catford, S.E.
Feb. 19, 1891		Jones, M. William, 433, Stretford-road, Old Trafford, Manchester
May 7, 1896		Jones, R. H., 55, Eldon-street, Newcastle-on-Tyne
Feb. 21, 1895		Joseph, Edgar, 42, Brondesbury-road, Kilburn, N.W.
May 4, 1893	Trans.	Jowett, Hooper A.D., D.Sc., 20, Kilmorie-road, Forest-hill, S.E.
Feb. 21, 1891		Jowett, William Hall, 2, Mayfield-road, Aigburth, near Liverpool
May 4, 1893		Káká, Sorabji Manekji, Devon Villa, Karachi, Sind, India
Dec. 16, 1886	Trans.	Kawakita, Michitada, Engineering College, Tokio, Japan
Feb. 17, 1881	Trans.	Kay, William E., 47, Camphill-street, Queen's-park, Glasgow
Dec. 5, 1889		Kaye, J. R., M.B., Medical Officer of Health, West Riding of Yorkshire, Wakefield
Dec. 20, 1883		Keeling, Frank, 190, Lake-avenue, Rochester, N.Y., U.S.A.
Dec. 7, 1882		Keen, Austin, 13, Lyndewoode-road, Cambridge
May 3, 1894		Kellas, Alex. Mitchell, B.Sc., 24, Cecile-park, Crouch-hill, N.
Mar. 19, 1874		Kellner, William, Ph.D., Chemical Department, Royal Arsenal, Woolwich, S.E.
Dec. 2, 1897		Kelly, Charles, Oakmere, Hawarden, Chester
April 4, 1867		Kemp, David Skinner, 52, Coverdale-road, Shepherd's Bush, W.
May 4, 1882		Kemp, William Joel, Mountfield, Robertsbridge, Sussex
Dec. 18, 1884		Kendall, George Frederic, B.A., The Hollies, Stratford-upon-Avon
Dec. 17, 1874		Kendall, James Alfred, Lonesome Chemical Works, Streatham Common, S.W.
Feb. 20, 1896		Kennicott, C. L., 4,050, Ellis-avenue, Chicago, Ill., U.S.A.
Dec. 5, 1889		Kenwood, Henry R., M.B., C.M. (Edin.), L.R.C.P. (Lond.), 9, Alexandra-villas, Finsbury Park, N.
Feb. 21, 1895		Kenyon, Rich. E., M.Sc., 102, Gainsborough-road, Wavertree, Liverpool
Dec. 20, 1883		Kerry, William H. R., Wheatlands, Windermere
Dec. 5, 1895		Kibble, W. O., G.P.O., Auckland, N.Z.
Dec. 7, 1882		Kilner, Frederick James, Royal Infirmary, Bristol

Date of Election.

Jan. 17, 1884		Kilpatrick, W. Stirling, 6, Colebrook-street, Hillhead, Glasgow
Feb. 15, 1872	Trans.	Kinch, Edward, Prof., Royal Agricultural College, Cirencester
Feb. 17, 1881	Trans.	King, Alfred John, Ingersley Vale, Bollington, near Macclesfield
Mar. 4, 1897		King, Herbert, B.Sc., The Grammar School, Dronfield, Derbyshire
Dec. 7, 1876		King, J. F., Laboratory of City Analyst, Edinburgh
Feb. 21, 1895		Kingdon, G. Holman, B.A., c/o Messrs. Crosfield, Limited, Warrington
Dec. 5, 1872	Trans.	Kingzett, Charles T., Elmstead Knoll, Chislehurst, Kent
Dec. 5, 1895		Kinnicut, Prof. L. P., 77, Elm-street, Worcester, Mass., U.S.A.
May 7, 1891	Trans.	Kipping, F. Stanley, Ph.D., D.Sc., F.R.S., University College, Nottingham
Dec. 2, 1886		Kirby, Herbert E., 307, High Holborn, W.C.
May 15, 1890		Kirk, Oliver, 19, Carlton-road, Workington
Feb. 21, 1895		Kirkcaldy, Patrick H., King's College, W.C.
June 19, 1873		Kitchin, Archibald, F.I.C., Scragill House, Whitehaven
May 16, 1889		Kitchin, John, The Middlesex Hospital, W.C.
Dec. 6, 1888		Knaggs, Alfred Battye, 2, Bradley-lane, Huddersfield
June 20, 1889		Knight, Frederick Charles, Boston and Colorado Smelting Company, Argo, Colorado, U.S.A.
Dec. 6, 1894		Knight, James, M.A., B.Sc., John-st. School, Bridgeton, Glasgow
June 18, 1896		Knight, J. B., Bushwood, Wanstead, Essex
May 3, 1894		Knight, Wm. Albt., Sexey's Trade School, Bruton, Somerset
May 16, 1878		Knights, James West, County Laboratory, Cambridge
Dec. 18, 1879		Knowles, Joshua, Stormer-hill, Tottington, Bury
Dec. 15, 1892		Knowles, Thomas Torrens, M.A. (Cantab.), 27, Peel-street, Princes Park, Liverpool
June 16, 1864		Knox, G. W., B.Sc., 16, Finsbury-circus, London, E.C.
Feb. 6, 1873		Koch, Walter Edward, M.A., F.G.S., Questre Mining Co., El Oro, Estava de Durango, viâ Jimenez, Mexico
Nov. 17, 1887	Trans.	Koga, Yoshimasa, The Imperial Mint, Osaka, Japan
June 17, 1886	Trans.	Kohn, Charles A., Ph.D., B.Sc., 20, Mulgrave-street, Liverpool
June 8, 1885		Koningh, Leonard de, 4, St. Martin's Road, Stockwell, S.W.
Dec. 15, 1892		Krause, Dr. G., Cothen, Germany
Feb. 17, 1859	Trans.	Kynaston, Josiah W., Chemical Laboratory, 3, Oak-terrace, Beech-street, Liverpool
Dec. 6, 1894		Ladell, R. S., 67, Church-road, Tranmere, Birkenhead
Feb. 16, 1888		Lafosse, Charles R., 37, Whiteladies'-road, Clifton, Bristol
May 4, 1893		Lamb, Edmund George, M.A., Old Lodge, Salisbury
Dec. 15, 1892	Trans.	Lamb, Thornton Charles, Tudor Lodge, Sylvan-road, Wanstead, N.E.
Feb. 16, 1893		Lambert, Wesley J., May Villa, Cantwell-road, Plumstead, S.E.
Jan. 18, 1877		Lancaster, William James, F.R.A.S., F.R.C.S., F.R.M.S., The Hollies, Handsworth Wood, Birmingham

Date of Election.	
Mar. 4, 1886	Lang, William, Cross Bank, Partick
Mar. 4, 1897	Lang, W. R., B.Sc., 9, Crown-gardens, Glasgow
June 18, 1885	Langer, Charles, Ph.D., Upmore, Milverton-terrace, Leamington
May 7, 1891	Langham, Rev. E. Norman, M.A. (Cantab.), F.L.S., Head Master, Rastrick Grammar School, Brighouse
Feb. 16, 1894	Trans. Lapworth, Arthur, D.Sc., 17, Bloomsbury-square, W.C.
June 21, 1883	Lascelles, B. P., B.A., Harrow
May 6, 1897	Lasseter, W. J. G., M.A., 10, Stanley-road, Oxford
April 15, 1880	Last, Frank B., Laboratory, 78, Mansell-terrace, Swansea
May 7, 1891	Trans. Lauder, Alexander, University College, Bangor, North Wales
Mar. 4, 1886	Trans. Laurie, Arthur P., Woodside, Baldwin Hill, Loughton
Nov. 16, 1876	Law, Channell, Ilsham Dene, Torquay
May 7, 1896	Law, H. E., 2304—6—8, Van Nesse Avenue, San Francisco, U.S.A.
Feb. 6, 1890	Trans. Law, Robert, F.R.M.S., F.I.C., The Royal Mint, Melbourne
June 17, 1850	Trans. Lawes, Sir John Bennet, F.R.S., Rothamsted, near St. Albans
June 17, 1880	Trans. Lawrance, Henry Awbrey, Avondale House, Bree-street, Cape Town
Dec. 3, 1896	Trans. Lawrence, W. T., B.A., Ph.D., 57, Prince's Gate, S.W.
Jan. 19, 1882	Laws, J. Parry, F.I.C., Westfield, Bath-road, Worcester
Feb. 2, 1888	Trans. Lawson, Thomas Atkinson, Ph.D., B.Sc., 114, Alexandra-road, N.W.
April 17, 1890	Trans. Laycock, William Frederick, Ph.D., 46, Boar Lane, Leeds
April 17, 1890	Lea, A. Sheridan, D.Sc., F.R.S., Caius College, Cambridge
Dec. 16, 1886	Leach, Walter, 21, St. Andrew's-place, Bradford
Dec. 6, 1894	Trans. Lean, Bevan, D.Sc., B.A., Laurel Bank, Ackworth, near Pontefract
Feb. 2, 1888	Lease, Frank E., Melapi Estate, Sandakan, British North Borneo
Dec. 3, 1891	Trans. Leather, J. Walter, Ph.D., c/o Messrs. Grindley and Co., 55, Parliament-street, S.W.
Dec. 5, 1889	Ledingham, L. Napier, Longley Farm, Longley, near Sheffield
Dec. 6, 1883	Lee, Herbert C., The New Westminster Brewery Company, Earl-street, Horseferry-road, S.W.
Feb. 1, 1883	Lee, Robert Brewer, B.Sc., B.A., 6, Warwick-street, Kensington, W.
Mar. 4, 1897	Lee, T. H., St. John del Rey Mining Co., Ltd., Morro Velleo, Villa Nova de Lima, Estado de Minas, Geraes, Brazil
June 18, 1891	Leeds, Frank H., 26, East Bank, Stamford-hill, N.
Feb. 6, 1873	Lees, Charles, Devonshire House, Bridlington Quay, Yorks.
Dec. 3, 1891	Leffler, Rudolf, 75, Harcourt-road, Sheffield
May 16, 1889	Legg, John Edmund, M.A., F.I.C., The Grammar School, Wood-bridge, Suffolk
May 7, 1891	Proc. Leicester, James, Ph.D., Technical College, Bristol
Jan. 17 1889	Leigh, Cecil, Birmingham Small Arms and Metal Company, Adderley Park Rolling Mills, Birmingham

Date of Election.

Dec. 2, 1897		Lemmey, Tom, B.A., Wellington College, Berks
Dec. 3, 1891		Lennox, Robert N., The Nook, Rose Bank, Crabb Tree, Fulham
June 17, 1886		Leon, John Temple, 38, Portland-place, W.
Feb. 15, 1894		Leonard, Norman, B.Sc., 61, Wolfington-road, West Norwood, S.E.
Jan. 19, 1882		Lescher, Frank Harwood, 60, Bartholomew-close, E.C., and 31, Devonshire-place, W.
Feb. 21, 1895	Trans.	Le Sueur, Henry Rondel, B.Sc., St. Thomas's Hospital, S.W.
June 18, 1896		Lethbridge, W. A., Ivy Cottage, St. David's, Exeter
Feb. 6, 1879	Trans.	Letts, Edmund Albert, Prof., D.Sc., Ph.D., Queen's College, Belfast
Mar. 15, 1888	Trans.	Lewes, Vivian B., 19, Park-row, Greenwich, S.E.
Mar. 20, 1884		Lewis, A. E., 7, Gilford-road, Sandymount, Dublin
Dec. 6, 1894	Trans.	Lewis, W. H., Exeter School, Exeter
Nov. 18, 1869	Trans.	Lewis, W. J., New Museums, Cambridge
Feb. 16, 1888	Trans.	Lewkowitsch, Julius, Ph.D., Lancaster-avenue, Fennel-street, Manchester
Feb. 21, 1878		Lichtenstein, T., Chemical Works, Silvertown, E.
June 18, 1896		Lidgey, C. R., 43, Marmora-road, Honor Oak, S.E.
May 5, 1892		Lindley, Hubert Edward, Rose Villa, Pinner-road, Harrow
April 15, 1886	Trans.	Ling, Arthur R., 45, Lambton-road, Cottenham Park, Wimbledon
Dec. 3, 1896		Littlefield, R. D., 4, Victoria-terrace, Hove, Sussex
Nov. 21, 1853	Trans.	Liveing, G. D., M.A., F.R.S., Cambridge
Nov. 7, 1872	Trans.	Liversidge, Archibald, F.R.S., Prof., University, Sydney, New South Wales
June 21, 1883		Livingston, W. J., London County Council, Spring-gardens, S.W.
Feb. 19, 1880	Trans.	Lloyd, Alfred, The Dome, Bognor, Sussex
Feb. 3, 1876	Trans.	Lloyd, F. J., Agricultural Laboratory, 4, Lombard-court, E.C.
May 4, 1893		Lloyd, Herbert, The Electric Storage Battery Co., Drexel Building, Philadelphia, U.S.A.
Dec. 3, 1896		Lloyd, T. H., Penygraig, Pontypridd
Dec. 3, 1896		Lockwood, T. W., Heckmondwike
Feb. 16, 1871		Lockyer, William John, 7, St. Julian's Farm-road, West Norwood, S.E.
Mar. 20, 1884		London, J. Edward, M.D., 62, Main-street, George Town, Demerara
April 18, 1872		Longstaff, George Blundell, M.A., M.B. Oxon., M.R.C.P., Highlands, Putney Heath, S.W.
Feb. 20, 1873		Loram, H. Y., 19, Hillside-road, Stamford Hill, N.
Feb. 7, 1878	Trans.	Louis, D. A., 77, Shirland-gardens, Maida Vale W.
May 4, 1882		Love, Edward G., Ph.D., 80, East 55th-street, New York, U.S.A.
June 15, 1882		Lovibond, Thomas Watson, F.I.C., The Tyne Brewery, New-castle-on-Tyne

Date of Election.

Dec. 18, 1884		Low, Charles William, M.B., Stowmarket
Dec. 15, 1886		Lowe, Charles, Summerfield House, Reddish, near Stockport
Feb. 21, 1878		Lowe, Walter Bezant, M.A., Stranraer School, Fareham, Hants
Feb. 3, 1876		Lowe, William Foulkes, A.R.S.M., 9 Hough-green, Chester
April 21, 1898	Trans.	Lowry, T. M., B.Sc., 28, St. Lawrence-road, West Kensington, W.
Feb. 15, 1894		Lucas, E. W., 225, Oxford-street, W.
Dec. 3, 1891		Ludlow, Lionel, Standard Bank of South Africa, Bulawayo, Rhodesia, and Southville, Swansea
Feb. 15, 1877	Trans.	Luff, A. P., M.D., B.Sc. (Lond.), 31, Weymouth-street, Cavendish-square, W.
Mar. 6, 1890	Trans.	Lumsden, John S., B.Sc., Ph.D. (Mun.), 5, Paradise-road, Dundee
Dec. 5, 1867	Trans.	Lunge, Dr. George, Polytechnicum, Zürich, Switzerland
Dec. 4, 1890	Trans.	Lunt, Joseph, B.Sc., Royal Observatory, Cape of Good Hope
Dec. 5, 1872	Trans.	Lupton, Sydney, A. Audley Mansions, 44, Mount-street, W.
Feb. 16, 1893	Trans.	Luxmoore, Charles M., D.Sc., University Extension College, and Kennet View, Mansfield-road, Reading
May 1, 1873		Lyon, J. B., Brigade Surgeon, Lieut.-Col. C.I.E., East India, U.S. Club, 16, St. James's-square, S.W., and 164, Sutherland-avenue W.
Feb. 19, 1874		Lyon, J. G., The Aire Tar Works, Knottingley, Yorks
Nov. 18, 1886	Trans.	Lyons, Albert Brown, A.M., M.D., 72 Brainard-street, Detroit, Mich., U.S.A.
Feb. 3, 1859		Lyte, F. Maxwell, M.A. (Cantab.), F.I.C., A.I.C.E., Hon.F.P.P.S., 60, Finborough-road, South Kensington, S.W.
June 20, 1878		Macadam, C. T., 61, Brixton-hill, S.W.
May 7, 1896		Macadam, H. E., Odam's Wharf, Victoria Docks, E.
Feb. 21, 1853		Macadam, Stevenson, Ph.D., F.R.S.E., Surgeons' Hall, Edinburgh
Feb. 2, 1888		Macadam, Stevenson, J. C. G., jun., Surgeons' Hall, Edinburgh
April 4, 1878		Macadam, W. Ivison, F.R.S.E., Professor New Veterinary College, Surgeons' Hall, Edinburgh
Dec. 2, 1886		Macan, Hugh, M.A., County Hall, Kingston-on-Thames
April 17, 1890		MacArthur, J. Stewart, 12, Knowe-terr., Pollokshields, Glasgow
May 6, 1897		MacCulloch, Charles, Ballarat Club, Ballarat, Victoria
Feb. 15, 1894		Macdonald, A. H., 81, Cambridge-street, Eccleston-square, S.W.
Dec. 6, 1894	Trans.	MacDonald, G. W., B.Sc., 4, Endsleigh Gardens, N.W.
May 7, 1891		MacDonald, William, G. Tung Wen Kwan, Imperial Coll., Pekin
Mar. 4, 1886		MacEwan, Peter, 4, Gresley-road, Hornsey-lane, N.
June 18, 1891		Macfie, R. A. Scott, M.A. (Cantab.), B.Sc., 34, Moorfields, Liverpool
Feb. 21, 1895		MacFarlane, Alex., 149, Manx-terrace, Blackley, Manchester
Dec. 2, 1880		Macfarlane, James A., Vancouver, B.C.
Mar. 6, 1890		Macintyre, Alfred E., Morrin College, Quebec, P.Q., Canada

Date of Election.

Dec. 2, 1887		Mackay, Angus, East Balmain, Sydney, N.S.W.
Dec. 4, 1890		Mackean, William, 14, Palmer-street, Westminster, S.W.
Dec. 3, 1874		Mackenzie, D. C., 106, Leadenhall-street, E.C.
Feb. 18, 1892		Mackenzie, Dr. William Cossar, Tewfikieh College of Agriculture, Gheezeh, Cairo
June 17, 1897		Mackenzie, J. E., B.Sc., Ph.D., Birkbeck Institution, Chancery-lane, E.C.
Jan. 15, 1844		MacLagan, Douglas, Sir, M.D., F.R.S.E., University of Edinburgh, and 28, Heriot-row, Edinburgh
Dec. 2, 1897		MacLaurin, J. S., D.Sc., Victoria-avenue, Mount Eden, Auckland, N.Z.
Dec. 2, 1897		Macmullen, Alan, B.A., 82, James-street, Dublin
Feb. 17, 1881		MacMunn, Charles A., M.A., M.D., F.R.M.S., Oakleigh, Wolverhampton
Feb. 1, 1880		Macnab, William, 14, Great Smith-street, Westminster, S.W.
June 4, 1885	Trans.	Macnair, Duncan Scott, Ph.D., B.Sc., 10, Maxwell Drive, Glasgow
April 19, 1888		MacSwiney, E., 2, Avondale-terrace, Harold's Cross-road, Dublin
April 21, 1864	Trans.	Mactear, James, F.R.S.E., 2, Victoria-street, Westminster, S.W.
May 1, 1862	Trans.	Madan, H. G., Bearland House, Gloucester
May 5, 1892		Major, George Harry, Devonshire-street, Ardwick, Manchester
Dec. 6, 1894		Makin, C. J. Shaw, 51, Earl's-court-square, S.W.
May 7, 1885		Mallet, F. R., 18, The Common, Ealing, W.
Dec. 17, 1857	Trans.	Mallet, J. W., Ph.D., M.D., F.R.S., University of Virginia, Albemarle Co., Va., U.S.N.A.
May 6, 1897		Mallinson, W. L., Gawthorp-green, Kirkheaton, near Huddersfield
Dec. 3, 1896		Manners, Hugh, M.A., B.Sc., Academy House, Airdrie, N.B.
Feb. 4, 1858		Manning, F. A.
Dec. 2, 1897		Mansford, C. J., B.A., Lady Manner's Grammar School, Bakewell
Feb. 7, 1853	Trans.	Marcet, W., M.D., F.R.S.,
May 16, 1895		Marchant, Robert Charles, P.A.S.I., M.R.A.C., Uffculme, Cullompton, Devon
Dec. 3, 1896		Marks, E. S., Cambrian Villa, Potts Point, Sydney, N.S.W.
Feb. 16, 1893	Trans.	Marsden, Fred, M.Sc., Ph.D., Bangor, North Wales
May 16, 1895		Marsden, Prosper, Royal Infirmary, Liverpool
June 16, 1881		Marsh, Charles W., Ph.D.
Feb. 15, 1883	Trans.	Marsh, J. E., M.A., University Museum, Oxford
Feb. 21, 1895		Marshall, Arthur, Laboratory, Leadenhall House, 101, Leadenhall-street, E.C.
Feb. 6, 1890	Trans.	Marshall, Hugh, D.Sc., F.R.S.E., Chemical Department, University of Edinburgh
June 18, 1896		Marshall, P. S., Union Laboratory, Half Moon-street, Huddersfield
Feb. 19, 1891		Marshall, Reginald Tom, Elmcroft, The Green, Southwick, near Brighton

Date of Election.

Nov. 20, 1890	Trans.	Marshall, T. Rhymer, D.Sc., 19, Sandyford-place, Glasgow
Dec. 6, 1888	Trans.	Marshall, William, 56, Primrose-mansions, Battersea Park, S. W.
June 16, 1887		Marshall, William, F.I.C., 149, Drake-street, Rochdale
June 15, 1893		Martin, Alexander Mitchell, Douglas Villa, Dunbeth-road, Coat-bridge
Mar. 4, 1897		Martin, C. H., 14, Aldred-street-crescent, Salford
Nov. 19, 1885		Martin, Lieut.-Col. Gerald Ward, F.R.G.S., H.M. Mint, Bombay
Dec. 6, 1883		Martin, W. H., 183, King's-road, Chelsea, S. W.
Feb. 16, 1893		Martin, William J., jun., Prof., Ph.D., M.D., Davidson College, Davidson, N.C., U.S.A.
April 7, 1870		Martindale, William, 10, New Cavendish-street, W.
June 1, 1871		Martineau, George, 21, Mincing-lane, E.C., and Gomshall Lodge, Gomshall, Surrey
Dec. 1, 1887		Martineau, Sydney, Northwood, Rydal-road, Streatham, S. W.
June 2, 1851	Trans.	Maskelyne, Nevil Story, F.R.S., Salthrop, Wroughton, Wilts
Feb. 6, 1890		Mason, Francis H., Queen-buildings, Hollis-street, Halifax Nova Scotia
Mar. 4, 1893		Mason, James, M.D., Otaki, N. Z.
Nov. 4, 1858		Mason, James
Dec. 5, 1889		Mason, James Braik, 2, Balgay-avenue, Dundee
Dec. 2, 1880		Mason, William Brandwood, 117, Derby-street, Bolton
Jan. 19, 1882	Trans.	Masson, Orme, M.A., D.Sc., Prof., The University of Melbourne, Victoria
Dec. 2, 1897		Masters, Edward, The Aloes, Hinckley-road, Leicester
Dec. 4, 1873		Masters, William, 82, Oxford-gardens, Notting Hill, W.
Feb. 20, 1896		Mathieson, L. W., North Wilts Technical School, Swindon
June 15, 1876	Trans.	Matthews, C. G., Abendberg, 31, Stapenhill-road, Burton-on-Trent
June 17, 1880	Trans.	Matthews, Francis Edward, Ph.D., Royal Indian Engineering College, Cooper's Hill, Staines, and Treberfydd, Englefield Green, Surrey
Dec. 2, 1897		Matthews, J. A., M.A., M.Sc., 4, First-place, Brooklyn, N.Y., U.S.A.
Jan. 17, 1884		Matthey, Edward, 78, Hatton-garden, E.C.
May 3, 1870		Matthey, George, F.R.S., 78, Hatton-garden, E.C.
Dec. 7, 1893		Mawer, William Frederick, 332, Kennington-road, S.E.
Dec. 7, 1865		Maxwell, Theodore, B.A., M.D. Camb., B.Sc. Lond., 29, Woolwich-common, S.E.
Dec. 3, 1896		Mayfield, A. S., Avenue House, Beverley-road, Hull
June 7, 1888		Mayhew, E. W. A.
Dec. 1, 1887		McArthur, John, F.R.S.E., 196, Trinity-road, Wandsworth Common, S.W.
Feb. 2, 1888		McBretney, Edmund G., Pontefract-road, Castleford, York
Feb. 6, 1890	Trans.	McConnell, Arthur H., 35, Bernard-street, Russell-square, W.C.

Date of Election.		
June 18, 1896		McConnell, William, jun., 25, Percy-gardens, Tynemouth
Feb. 4, 1875		McCowan, William, F.I.C., 44, Alexandra-road, Gipsy Hill, S.E.
May 7, 1896	Trans.	McCrae, John, jun., Ph.D., The Yorkshire College, Leeds
Dec. 5, 1895		McCreath, James, Aucherwin, Maybole, Ayr, N.B.
Nov. 20, 1890		McCubbin, William A., 8, Cook-street, Liverpool
Dec. 6, 1894		McCutcheon, Jas., Glencona, Lanark
Dec. 17, 1857		McDougall, Alexr., 61, Liverpool-road, Birkdale, Southport
Dec. 17, 1874		McDougall, John, Clifton House, Greenwich Park, S.E.
June 15, 1893		McElroy, K. P., 1412, 16th-street, Washington, D.C., U.S.A.
Feb. 17, 1898		McEwen, A. F.
Feb. 18, 1892		McFall, J. E. Whitley, Bankfield-road, West Derby, Liverpool
May 16, 1895		McGlashan, John, Sugar Works, Cawnpore
Mar. 3, 1887	Trans.	McGowan, George, Ph.D., 3, Mount-avenue, Ealing
May 4, 1893		McGregory, Joseph Frank, Prof., Hamilton, New York, U.S.A.
June 15, 1893		McKerrow, Charles Alexander, 18, Exchange-street, Manchester
May 5, 1892		McKerrow, William James, D.Sc., Messrs. Field and Co., Upper Marsh, Lambeth, S.W.
Feb. 6, 1868	Trans.	McLeod, Herbert, F.R.S., Indian Civil Engineering College, Cooper's Hill, Staines
June 7, 1894		McLeod, Jas., 5, Gladstone-terrace, Paisley
Feb. 17, 1881		McMillan, Walter George, 8, Leigham Court-road West, Streatham, S.W.
April 4, 1889	Trans.	McMurtry, George Cannon, Wallaroo Smelting Works, Wallaroo, S. Australia
Feb. 21, 1895		McVey, W. B., College of Physicians and Surgeons, Boston, U.S.A.
Feb. 18, 1892		Meacham, Chas. Stephen, Pettridge, Maidstone
June 18, 1896		Meggitt, Loxley, The Laboratory, Sutton-in-Ashfield, Notts.
Feb. 16, 1871	Trans.	Meldola, Raphael, F.R.S., 6, Brunswick-square, W.C.
Feb. 21, 1895		Meldrum, Robt., Cockranfield, Millikan Park, Renfrewshire
Feb. 15, 1894		Melland, Godfrey, B.Sc., Mason College, Birmingham
May 20, 1875		Melmore, Pattinson B., Chemical Laboratory, Maryport
Dec. 18, 1884		Mercer, Francis M., 89, Bishopsgate-street-within, E.C.
Dec. 5, 1889		Mercer, Thomas, Great Hey, Edenfield, near Bury, Lancashire and Ring Bank Brewery, Edenfield, near Bury
May 7, 1896		Merrett, W. H., Lambeth Brass and Iron Works, Short-street, Lambeth
May 7, 1891		Merrills, Frederick Johnson, 13, Rutland Park, Sheffield
May 6, 1897		Merson, G. F., 24, Newgate-street, Newcastle-on-Tyne
April 20, 1876	Trans.	Messel, Rudolph, Ph.D., 30, Ebury-street, S.W.
June 21, 1888	Trans.	Miers, Henry A., M.A., F.G.S., F.R.S., Magdalen College, Oxford
Feb. 18, 1892	Trans.	Millar, James Hill, Davy-Faraday Research Laboratory, Albe-marle-street, W.
Dec. 18, 1843		Millar, James

Date of Election.		
Feb. 19, 1891		Millard, Edgar J., F.R.M.S., 33, Lothair-road, Finsbury Park, N.
Feb. 19, 1880	Trans.	Miller, A. K., Ph.D., Kilvert's-buildings, Withy-grove, Manchester
May 6, 1897		Miller, E. H., M.A., Ph.D., Columbia University, New York City, U.S.A.
Feb. 21, 1889		Miller, Harry East, Ph.D., 1015, Chestnut-street, Oakland, California
April 4, 1889	Trans.	Miller, James Bruce, A.I.C., Rubislaw Den, North Aberdeen
Dec. 1, 1887		Miller, John A., M.Sc., Ph.D., Niagara Univesity, Buffalo, New York
May 7, 1885	Trans.	Miller, N. H. J., Ph.D., Harpenden, Hertfordshire
Dec. 3, 1896		Miller, W. M., Caledonia Estate, Wellesley Province, Penang, S.S.
June 15, 1893	Trans.	Mills, Charles, 21, St. Mary Abbotts-terrace, W.
Dec. 18, 1862	Trans.	Mills, E. J., D.Sc., F.R.S., Young Professor of Technical Chemistry in the Glasgow and West of Scotland Technical College, 60, John-street, Glasgow
Feb. 17, 1898		Mills, W. H., B.A., Jesus College, Cambridge
May 7, 1885		Milne, Alexander, M.A., M.B.
June 21, 1877		Milne, G. A., Chemical Laboratory, 41, Vernon-street, Bolton
May 5, 1892		Milnes, Ernest E., 16, Ashfield, Bradford
Dec. 1, 1887		Mingaye, John C. H., Department of Mines, Assay Branch, Sydney
April 21, 1898		Mitchell, A. H., B.Sc., 1, Brickfield-terrace, Tiverton, Devon
May 7, 1891	Proc.	Mitchell, Charles Ainsworth, B.A. Oxon., c/o Messrs. Beaufoy and Co., South Lambeth-road, S.W.
May 6, 1897		Mitchell, Tom, Cemetery House, Shaw, near Oldham
June 18, 1896		Mitra, Asutosh, Rai Buhadur, Chief Medical Officer, Kashmir
Feb. 16, 1893		Mole, H. Bloome, Hill Side, Shepton Mallet
Feb. 15, 1872	Trans.	Mond, Ludwig, Ph.D., F.R.S., 20, Avenue-road, Regent's Park, N.W.
Feb. 18, 1892		Mond, Robert Ludwig, M.A., F.R.S.E., The Poplars, 20, Avenue-road, Regent's Park, N.W.
Dec. 18, 1879		Mondy, Edmund F., Dacca College, Dacca, Bengal
May 4, 1892		Monson, H. J.,
Mar. 3, 1887	Trans.	Moody, G. Tattersall, D.Sc., Lorne House, North Dulwich, S.E.
Dec. 2, 1897		Moon, P. G. G., The Laboratory, British Gas Light Co., Ltd., Norwich
May 5, 1892		Moor, Cresacre George, B.A., 4, Dane's Inn, Strand, W.C.
Feb. 19, 1891		Moore, Frederick Herbert, Strada degli Argentieri, 19, Messina, Sicily
Mar. 6, 1890		Moore, Ira, Ph.D., 64, Mottram-road, Hyde, near Manchester
Dec. 3, 1896		Moore, L. C., 31, Tunley-road, Upper Tooting Park, S.W.

Date of Election.	
May 6, 1897	Morgan, F. F. de, 66, Clapham-road, S.W.
Feb. 17, 1898	Trans. Morgan, G. T., 35a, Russell-road, Kensington, W.
Jan. 7, 1888	Morgan, John James, 14, Bryntirion-street, Dowlais, Glamorgan
Dec. 7, 1893	Morgan, J. R., 57, Coldstream-street, Llanelly
June 20, 1895	Morison, James, Colonial Sugar Co., Ltd., 5, O'Connell-street, Sydney, N.S.W.
June 17, 1880	Trans. Moritz, Edward R., Ph.D., 72, Chancery-lane, W.C.
Dec. 18, 1879	Trans. Morley, H. Forster, M.A., 47, Broadhurst-gardens, South Hampstead, N.W.
May 16, 1895	Trans. Morrell, R. S., M.A., Ph.D., Gonville and Caius College, Cambridge
May 5, 1892	Morris, Albert, B.Sc., Fern Bank, Dunkinfield
Feb. 19, 1880	Trans. Morris, G. Harris, Ph.D., 72, Chancery-lane, W.C., and 18, Gwendwr-road, West Kensington, W.
Dec. 3, 1891	Morris, Joseph, Ph.D., 87, Old Trafford-road, Eccles, Manchester
May 7, 1891	Morrison, George R., Richmond House, Plaistow, Essex
Dec. 15, 1851	Morson, Thomas, 124, Southampton-row, Russell-square, W.C.; and 42, Gordon-square, W.C.
Feb. 16, 1872	Morton, Edward Handfield, 11, Exeter-road, Brondesbury, N.W.
Dec. 7, 1893	Morton, Frederick, 101, Quarmby-road, Huddersfield
April 17, 1890	Trans. Mosenthal, Henry de, 220, Winchester House, Old Broad-street, E.C.
Dec. 3, 1896	Moss, Frank A., Menzies, W. Australia
Jan. 19, 1871	Moss, John, 39, Tressillian-road, St. John's, S.E.
Jan. 19, 1871	Moss, Richard J., F.I.C., St. Aubyn, Ballybrack, Co. Dublin
Feb. 17, 1898	Moss, W. E., 15, New Inn Hall-street, Oxford
Dec. 3, 1896	Mothe, J. T. de la, Grand Bacolet Estate, St. David's, Grenada, W.I.
April 15, 1886	Moul, Frank, Aldersgate Chemical Works, Southall
Feb. 16, 1884	Moyle, R. E., M.A., Heightley, Chudleigh, Devon
Jan. 17, 1889	Muir, James, South Haven, Beach-road, Weston-super-Mare
June 18, 1896	Muir, J. Stanley, B.Sc., The Gold and Silver Extraction Co., Ltd., 208-210, McPhee-buildings, Denver, Colorado, U.S.A.
Feb. 16, 1871	Trans. Muir, M. M. Pattison, M.A., Fellow and Prælector in Chemistry, Gonville and Caius College, Cambridge
Mar. 30, 1870	Muirhead, Alexander, D.Sc., Sherborne Lodge, Shortlands, Kent
Feb. 3, 1859	Trans. Müller, Hugo, Ph.D., F.R.S., 110, Bunhill-row, E.C.; and 13, Park-square East, Regent's Park, N.W.
May 4, 1893	Proc. Munby, Alan E., Felstead School, Essex
Mar. 15, 1888	Munroe, Charles E., Prof. Columbia University, Washington, D.C., U.S.A.
Dec. 7, 1871	Munro, Donald, M.D., C.M., D.P.H., Medico-Legal Department, University of Glasgow
Feb. 17, 1876	Trans. Munro, J. M. H., D.Sc., 9, South Parade, Bath

Date of Election.

May 4, 1893		Murray, J. Alan, B.Sc., 5, Caergog-terrace, and University College of Wales, Aberystwyth
Feb. 15, 1894		Murray, John Moore, Municipal Technical School, Arundel-street, Portsmouth
Dec. 4, 1890	Trans.	Murray, Thomas Smith, D.Sc., Chemical Department, The University, Aberdeen
Jan. 21, 1869		Muspratt, E. K., Seaforth-hall, near Liverpool
Dec. 3, 1873		Muspratt, Sidney Knowles, 24, Grove-park, Liverpool
Dec. 3, 1896		Muter, A. H. M., A. I. C. Laboratory, 325, Kennington-road, S.E.; and The Châtelet, Horley, Surrey.
Nov. 3, 1870	Trans.	Muter, John, Ph.D., F.R.S.E., F.I.C., Laboratory, 325, Kennington-road, London, S.E.; and The Châtelet, Horley, Surrey
Dec. 4, 1890	Trans.	Myers, Harry C., Ph.D., University of Washington, Seattle, Wash., U.S.A.
Feb. 18, 1892	Trans.	Myers, William Shields, M.Sc., 98, Easton-avenue, New Brunswick, N.J., U.S.A.
Feb. 3, 1887		Nagel, David Henry, M.A., Trinity College, Oxford
Mar. 5, 1874		Napier, Arthur S., c/o Herren Mayer and Müller, 2, Prinz Louis Ferdinand strasse, Berlin
June 15, 1893		Napier, John Watson, Gas Works, Auchterarder, N.B.
Dec. 3, 1891		Naylor, William, 16, Walton's-parade, Preston
April 4, 1878		Naylor, W. A. H., 38, Southwark-street, S.E.
Dec. 3, 1891		Neilson, Thos.
April 4, 1878	Trans.	Neville, R. H. C., Crown Lea, Malvern
June 1, 1871	Trans.	Nevill, Edmund Neville, Gov. Lab., Durban, Natal
April 17, 1890	Trans.	Neville, Francis Henry, F.R.S., Sidney College, Cambridge
June 16, 1892		Newall, John Fenton, 8, Market-place, Manchester
June 4, 1885		Newbolt, Francis George, Balliol College Laboratory, Oxford
April 19, 1860	Trans.	Newlands, John A. R., Laboratory, 2, St. Dunstan's-hill, E.C.
Feb. 18, 1864		Newlands, B. E. R., 2, St. Dunstan's-hill, E.C.
Dec. 3, 1891		Newlands, William, P. R., 1, Mildenhall-road, Lower Clapton, N.E.
April 4, 1889		Newsholme, G. T. Wilkinson, 27, High-street, Sheffield
June 7, 1894	Trans.	Newth, G. S., Royal College of Science, South Kensington
May 16, 1895		Newton, C. B., Gas Works, Carlisle
Mar. 4, 1886		Newton, Walter, Beech Villa, Park-lane, Macclesfield
Mar. 1, 1883		Newton, William, Ph.D., F.I.C., 39, Mincing-lane, London, E.C.
Dec. 15, 1892		Nickolls, J. Bate, The Laboratory, Guernsey
Feb. 16, 1870	Trans.	Nicholson, Edward, Brigade Surgeon, Lieut.-Col., 10, Alexander-road, Waterloo, Liverpool
June 4, 1885	Trans.	Nicholson, T. Goddard, M.B. Lond., B.Sc., M.R.C.S., L.R.C.P., Palmer House, Great Marlow

Date of Election,		
Dec. 5, 1889		Nickels, Wallace Christopher, 54, Dyne-road, Brondesbury, N.W.
Feb. 1, 1883	Trans.	Nicol, W. W. J., 15, Blacket-place, Edinburgh
June 7, 1894		Nixon, Alf., Central School, Deansgate, Manchester
May 6, 1869		Noble, Captain Sir Andrew, K.C.B., F.R.S., Elswick Ordnance Works, Newcastle
Dec. 5, 1889		Norman, John T., Avalon, Putney Common, S.W.
April 4, 1861		Norrington, Frederick, 5, Downfield-road, Clifton, Bristol
June 16, 1892		Norris, Charles James, 24, Ravenscourt-gardens, Hammersmith
Mar. 4, 1897	Trans.	North, Barker, 3, Manor-terrace, Felixtowe
May 5, 1892		Northing, John, The Murrough, Wicklow
Dec. 18, 1854		Norton, Fletcher, Longtown, Abergavenny
April 4, 1878		Norton, Prof., T. H., Ph.D., University of Cincinnati, Ohio U.S.A.
June 18, 1891		Notter, J. Lane, M.A., M.D., West Cliff, Woolstone, Southampton
May 4, 1893	Proc.	Oats, William Henry, Broomhall Park, Sheffield
Mar. 4, 1886		Obach, Eugene, Ph.D., F.I.C., 113, Victoria-road, Old Charlton, Kent
May 15, 1890		Oddy, Robert Walter, Waterhouse, Toad-lane, Rochdale
Jan. 19, 1873		Odling, Walter, 132, High-street; and Messrs. Bass and Co., Burton-on-Trent
Jan. 17, 1848	Trans.	Odling, Williams, M.B., F.R.S., 15, Norham-gardens, Oxford
May 4, 1871		Ogston, G. H., Analytical Laboratory, 39, Lime-street, E.C.
June 20, 1889		O'Mahony, D. J., Municipal-buildings, Cork
Dec. 4, 1890	Trans.	Ormandy, Wm. Reginald, Gamble Institute, St. Helens, Lancs.
Nov. 4, 1869		Orme, Temple A., University College, W.C.; and 213, Uxbridge-road, W.
May 16, 1872		Ormerod, Joseph Arderne, M.D., M.R.C.P., The Medical Committee Room, St. Bartholomew's Hospital, E.C.
Dec. 6, 1894		Ormerod, T., 362, Padiham-road, Burnley, Lancs.
Dec. 1, 1887		Ormiston, Archibald R., Heathland, Uddingston; and 203, St. Vincent-street, Glasgow
June 15, 1893		Orr, Alexander, 109, Pitt-street, Sydney, Australia
Feb. 21, 1884	Proc.	Orsman, W. J., jun., The Roburite Explosives Co., Gathurst, near Wigan
May 6, 1897		Orton, K. J. P., B.A., Ph.D., 55, Amsbury-avenue, Streatham-hill, S.W.
Mar. 17, 1881	Trans.	O'Shea, L. Trant, B.Sc., University College, Sheffield
Dec. 1, 1887		Ostersetzer, Julius, Messrs. W. and H. M. Goulding, Manure Manufacturers, North Wall, Dublin
April 20, 1876	Trans.	†O'Sullivan, C., F.R.S., 140, High-street, Burton-on-Trent
Mar. 1, 1883	Trans.	O'Sullivan, James, High Bank, Burton-on-Trent

† Longstaff Medallist, 1884.

Date of Election.

Mar. 17, 1887		O'Sullivan, Patrick T., M.B., B.C.L., 34, South Mall, Cork
May 7, 1891		Ough, Lewis, Curzon-terrace, Sparkenhoe-street, Leicester
Feb. 16, 1888		Overbeck, Otto C. J. G. L., Chantry House, Great Grimsby
June 16, 1887		Overend, Fred. Lawrence, B.A. (Oxon), Royal Grammar School, Sheffield
June 18, 1896		Overton, J. H., Technical School, Marlborough-road, Banbury
Feb. 16, 1893		Owen, Robert Henry, Bush Hotel, Dowlais
Dec. 15, 1851		Oxland, Robert, Dr., 32, Ravenswood-road, Redland, Bristol
Dec. 21, 1871	Trans.	Page, Frederick James Montague, B.Sc., 54, Sutherland-street, Pimlico, S.W.
June 18, 1896		Page, H. M., Headmaster, Govt. College of Science, Poona, Bombay Presidency
April 21, 1898		Pakes, W. C. C., 14, Trinity-square, S.E.
Jan. 17, 1884		Pallister, J. W., B.Sc., 22, Grimthorpe-terrace, Headingley, Leeds
May 4, 1882		Palmer, Alfred Neobard, Ingle-nook, Bersham-road, Wrexham
April 19, 1888		Palmer, Henry John, Summerleaze, Yelverton, R.S.O., Devon
April 17, 1879		Palmer, Walter, Univ. Extension College, Reading
Mar. 4, 1897		Parker, C. H., The Copthornes, Copthorne-road, Pennfields, near Wolverhampton
Jan. 19, 1882		Parker, Joseph R., Avondale, Beaver-road, Ashford
May 3, 1894	Trans.	Parker, Matt. A., B.Sc., 13, Hamilton-crescent, Partick, Glasgow
Dec. 7, 1882		Parker, R. H., 35, Clifton-road, Maida Vale, W.
Nov. 20, 1890		Parkes, Thomas, M.A., 30, Hopwood-street, Barnsley
Nov. 2, 1865	Trans.	Parkinson, James, F.G.S., Queen's-chambers, Pirie-street, Adelaide, South Australia
May 4, 1893		Parrish, S., 1, Highfield-terrace, Kingston-road, Leeds
Feb. 18, 1892		Parry, Ernest John, B.Sc., 134, Upper Thames-street, E.C.
May 17, 1888		Parsons, William, Dispensary, St. Bartholomew's Hospital, E.C.
April 21, 1870		Patchett, Isaac, F.I.C., 11, Osborne-terrace, Field-hill, Batley
Feb. 15, 1894	Trans.	Paterson, David, Lea Bank, Rosslyn, Midlothian, N.B.
Mar. 5, 1885	Trans.	Patterson, George, The Manbré Saccharine Co., Hammersmith, W.
May 7, 1896		Patterson, J. W., 14, Mitchell-street, W. Hartlepool, Durham
May 15, 1895		Patterson, L. G., Cumberland, Maryland, U.S.A.
Mar. 17, 1870	Trans.	Patterson, T. L., Maybank, Finnart-street, Greenock
Dec. 3, 1863	Trans.	Pattinson, John, 75, The Side, Newcastle-upon-Tyne
Mar. 5, 1863	Trans.	Paul, Dr. B. H., Analytical Laboratory, 20, Victoria-street, Westminster, S.W., and Parkside, Kingston Vale, Putney, S.W.
Dec. 3, 1885	Trans.	Paul, Lewis Gordon, Ph.D., Messrs. Read, Holliday and Sons, Huddersfield
Feb. 15, 1894		Paulusz, Richd., Maradana, Colombo, Ceylon
June 18, 1896		Payne, Arthur, c/o Messrs Mawson and Swan, Mossley-street, Newcastle-on-Tyne

Date of Election.

Dec. 7, 1893		Payne, George F., M.D., Atlanta, Georgia, U.S.A.
Feb. 15, 1894		Pearson, William Henry, 6, Fenchurch-buildings, E.C.
Jan. 16, 1874	Trans.	Pearce, William, Chemical Works, Bow Common, E.
May 7, 1896	Trans.	Pechmann, H. von, Prof., Tübingen, Germany
Feb. 15, 1894		Peden, John, jun., Chemical Laboratory, 11, Duff-street, Greenock
Feb. 4, 1870	Trans.	Pedler, Alexander, Prof., F.R.S., Presidency College, and 5, Russell-street, Calcutta
May 20, 1886	Proc.	Pendlebury, William Henry, M.A., 6, Gladstone-terrace, Dover
Mar. 7, 1870		Penney, M. D., 11, High-street, Hull
Dec. 5, 1895		Pennington, W. H., Field House, Rochdale
Dec. 16, 1886		Pentecost, Stephen James, Nottingham-road, New Basford, Nottingham
Jan. 17, 1889	Trans.	Percival, John, M.A., S.E. Agric. Coll., Wye, near Ashford
April 17, 1884	Trans.	Perkin, A. G., 8, Montpelier-terrace, Hyde Park, Leeds
June 18, 1891	Trans.	Perkin, Frederick M., Ph.D., Borough Polytechnic, Borough-road, S.E.
Dec. 15, 1856	Trans.	† Perkin, W. H., LL.D., Ph.D., F.R.S., The Chestnuts, Sudbury, Harrow
April 17, 1884	Trans.	Perkin, W. H., jun., F.R.S., Fairview, Wilbraham-road, Fallow-field, Manchester
Feb. 6, 1890	Trans.	Perman, Edgar Philip, D.Sc., University College, Cardiff
Dec. 6, 1888		Perry, George Edward, 6, Norwood-villas, Edgbaston, Birmingham
June 16, 1881		Philip, Arnold, A.R.S.M., B.Sc., Lond., F.I.C., The Merchant Venturers' Technical School, Bristol
Dec. 2, 1897		Philip, J. C., B.Sc., Ph.D., Sidney Sussex, College, Cambridge
Feb. 1, 1887		Phillips, A. G., 11, Essex-villas, Phillimore-gardens, Kensington, W.
June 20, 1889		Phillips, Benjamin, Victoria House, Byculla, Bombay
May 6, 1897		Phillips, H. E. W., B.A., 47, Chalfont-road, Oxford
Feb. 16, 1882		Phillips, Henry Harcourt, 183, Moss-lane East, Manchester
Feb. 21, 1889		Phillips, Henry Joshua, Palace-chambers, Westminster, S.W.
May 6, 1897	Trans.	Pickard, R. H., B.Sc., Southfields, Priory-road, Edgbaston, Birmingham
Feb. 19, 1891		Pickering, M. Samuel, B.Sc., Lond., 38, Price-street, Burslem
Feb. 7, 1878	Trans.	Pickering, Spencer Percival Umfreville, M.A., F.R.S., 48, Bryanston-square, W., and Harpenden, Herts
April 17, 1890	Trans.	Picton, Harold, B.Sc., Parmiters School, Approach-road, Victoria-park, N.E.
June 7, 1894		Pike, E. Brookes, 515, Romford-road, Forest-gate, E.
Jan. 15, 1874	Trans.	Pike, William Herbert, Ph.D., University, Toronto, Canada
Dec. 20, 1883		Pilley, John J., Ph.D., 167, Camberwell Grove, S.E.
May 7, 1896		Pilley, T. W., 33, Grove-hill-road, Denmark-hill, S.E.

† Longstaff Medallist, 1888.

Date of Election.

Dec. 5, 1889		Ping, William, 2, Sandbourne-road, Brockley, S.E.
Feb. 21, 1889		Pingstone, G. Arthur, The Goldfields of Matabele Land, Limited, Bulawayo, Rhodesia, S.A.
May 17, 1881		Pisani, O. V., Effingham-house, Arundel-street, Strand, W.C.
Feb. 16, 1882		Pitt, Theophilus, 16, Coleman-street, E.C.
Feb. 16, 1893		Platt, Charles, Ph.D., Hahnemann Med. Coll., Philadelphia, U.S.A.
April 4, 1889		Platts, John Charles, 54, Marlborough-road, Moor Oaks, Sheffield
Nov. 15, 1860		Player, J. H., 16, Prince Arthur-road, Hampstead, N.W.
Feb. 23, 1841	Trans.	*Playfair, Rt. Hon. Lord, K.C.B., F.R.S., 68, Onslow Gardens
Dec. 2, 1880	Trans.	Plimpton, R. T., Ph.D., 23, Lansdowne-road, Clapham-road, S.W.
June 7, 1888		Pollard, F. Ernest, c/o Mrs. G. Pollard, Ware-road, Hertford
May 7, 1896		Pollitt, R. B., 2, Woodleigh-villas, Stowmarket
May 4, 1897		Pollitt, Samuel, B.Sc., Commercial Travellers' School, Pinner
June 17, 1897		Pollock, W. R., Kirkland, Bonhill, Dumbartonshire
Feb. 15, 1894		Pollok, J. Holms, B.Sc., Royal College of Science, Dublin
Dec. 4, 1890		Pond, James Alexander, Auckland, New Zealand
Dec. 4, 1848		Pontifex, Edmund A., M.I.C.E., 72, Cornwall Gardens, S.W.
Mar. 6, 1862		Pooley, Thomas A., B.Sc., F.I.C.,
Feb. 17, 1898		Pope, T. H., South-street, Ponders End, N.
Feb. 19, 1891	Trans.	Pope, Wm. Jackson, Goldsmith's Institute, New Cross, S.E., and 6, Gt. James-street, Bedford-row, W.C.
Dec. 18, 1884	Proc.	Porter, T. Cunningham, Rev., Eton College, Windsor
June 20, 1895		Potter, A. E., M.A., B.Sc., Inspector of Schools, Rangoon, Burmah
Dec. 6, 1883		Potter, Charles E., c/o Messrs. Tate and Sons, Love-lane Sugar Refinery, Liverpool
Dec. 3, 1896		Potts, H. W., Euroa, Victoria, Australia
Feb. 21, 1895		Powell, H. James, 530, Lordship-lane, S.E.
Dec. 3, 1896		Power, F. B., Ph.D., 42, Snow-hill, E.C.
Feb. 21, 1884		Power, Francis R., The Royal Mint, Melbourne
May 19, 1864		Prentice, Manning, Woodfield, Stowmarket
Mar. 2, 1876	Trans.	Prescott, Albert B., M.D., University, Ann Arbor, Michigan, U.S.A.
May 4, 1882		Price, Arthur F., 524, Sacramento-street, San Francisco
Dec. 5, 1895	Trans.	Priest, Martin, Government Mint, Nankin, China
Jan. 17, 1889		Priestley, Charles W., B.Sc., Vivian Institute, Torquay
Feb. 17, 1870		Pritchard, Prof. William, President Royal Veterinary College, N.W.; and 5, Regent's Park-road, Gloucester-gate, N.W.
June 15, 1871	Trans.	Procter, Henry R., F.I.C., The Yorkshire College, Leeds, and Thornleigh, Ilkley, Yorkshire
April 4, 1889		Proctor, Charles, Upland House, 359, Upland-road, Dulwich, S.E.
May 7, 1896		Proude, James, 30, Cromwell-terrace, Halifax
Jan. 17, 1889		Provis, John, Zechan, Tasmania
Mar. 4, 1897		Pullar, H. S., Rosebank, Perth, N.B.

* Original Member.

Date of Election.

June 15, 1882		Pullar, Rufus D., Ochil, Kinnoul, Perth
Feb. 18, 1892	Trans.	Pullinger, William, B.A., Comstall-road, Romiley, Stockport
June 21, 1883		Purcell, M. F., 41, Lower Bagot-street, Dublin
June 3, 1875	Trans.	Purdie, Thomas, F.R.S., Ph.D., B.Sc., Assoc. R.S.M. University, St. Andrews, N.B.
Dec. 2, 1886		Pye, L. S. M., A.M.I.C.E., M.I.C.E., F.R.I., 44, Kensington Park-gardens, W.
Mar. 4, 1868		Quibell, Oliver, Magnus Lodge, Newark-on-Trent
Dec. 6, 1894		Quinn, Gerald G., 16, Albert-street, Newcastle-under-Lyme, Staffs.
Feb. 15, 1894		Quinn, J. Cardwell, c/o The Rubber Tyre Manufacturing Co., Ltd., Aston Cross, Birmingham
Mar. 4, 1897		Ralston, William, B.Sc., 337, Cathcart-road, Glasgow
Dec. 15, 1892	Trans.	Ramage, Hugh, Royal College of Science, Dublin
Nov. 15, 1888		Ramsay, A. Alexander, Anan Villa, Rose-road, Auckland
Mar. 20, 1873	Trans.	† Ramsay, William, Ph.D., F.R.S., University College, W.C., and 12, Arundel-gardens, Notting-hill, W.
May 7, 1891		Randall, Percy Morrice, 3, Belsize Park-gardens, N.W.
April 18, 1843		Randall, William B., 52, Archers-road, Southampton
Dec. 3, 1885		Ranken, Charles, Stockton-road, Sunderland
May 16, 1889		Ransom, Francis, 12, Baneroft, Hitchin
April 21, 1898		Ratcliffe, Walter, 21, Mawdsley-street, Bolton
June 17, 1880		Rawson, Christopher, 2, Melbourne-place, Bradford
Jan. 17, 1884	Trans.	Rawson, Sidney George, D.Sc., Technical Schools, Huddersfield
April 4, 1889	Trans.	Read, Arthur A., 3, Fitzalan-place, Cardiff
June 20, 1895		Read, E. J., B.A., 49, Aston-street, Ifley-road, Oxford
Nov. 20, 1890		Redding, Richard James, 17, Leghorn-road, Plumstead, S.E.
Jan. 15, 1874	Trans.	Reddrop, Joseph, Laboratory, L. and N.W. Ry., Crewe
July 16, 1892		Redman, Henry Ramsden, 150, Canterbury-road, New Brompton
Jan. 18, 1866		Redwood, Boverton, F.R.S.E., 4, Bishopsgate-street-within, E.C.
June 20, 1889		Redwood, Robert, 4, Bishopsgate-street-within, E.C.
Mar. 17, 1887		Redwood, T. Horne, 15, Red Lion-square, W.C.
Nov. 18, 1886	Trans.	Rée, Alfred, Ph.D., Guildhall Chambers, Lloyd-street, Manchester
Nov. 16, 1882	Proc.	Reed, Lester, F.I.C., Hyrst-hof, 8, South Park-hill-road, Croydon, S.E.
Dec. 7, 1893		Rees, George Percival
April 15, 1880		Regester, William, Lawn-lodge, Isleworth, Middlesex
Dec. 2, 1897		Reid, A. F., Stair Bridge, Stair, Ayrshire
Feb. 17, 1898		Reid, J. B., 6, Southfield-terrace, Skipton, Yorks.
Dec. 7, 1893		Reid, Thomas Anderson, Wincham-house, Lostock, Gt. Alton, Northwich

† Longstaff Medallist, 1897.

Date of Election.

Dec. 15, 1881		Reid, Walter Francis, Fieldside, Addlestone, Surrey
May 7, 1896		Reissman, C. H., B.A., B.Sc., Saxony-villa, Oppidans-road, Primrose-hill, N.W.
June 17, 1886		Remington, J. Price, Prof., 1832, Pine-street, Philadelphia, Pa., U.S.A.
Mar. 4, 1897		Remington, J. S., Dromore, Milverton, Leamington
Feb. 6, 1879	Trans.	Rennie, Edward H., Ph.D., University of Adelaide, S. Australia
Feb. 17, 1898	Proc.	Renwick, F. F., Glengall, Woodford Green, Essex
May 17, 1888	Trans.	Reynolds, Colonel Henry Charles, Thorncliff, Landown-road, Cheltenham
June 19, 1873	Trans.	Reynolds, James Emerson, Prof., D.Sc., M.D., F.R.S., Trinity College, Dublin
Nov. 19, 1857		Reynolds, Richard, 13, Briggate, Leeds
Feb. 17, 1898	Trans.	Reynolds, W. C., 8, Rosenau Crescent, Battersea, S.W.
June 18, 1891		Rhodes, Edward, Oaklands, Overton, Frodsham, Cheshire
April 4, 1889		Richards, Duncan T., 3, Madeira-terrace, Westoc-lane, South Shields
Jan. 17, 1889		Richards, Edgar, 341, West 88th Street, New York, U.S.A.
Jan. 17, 1889		Richards, Percy A. E., F.I.C., 12, Wolverton-gardens, Hammer-smith, W.
June 17, 1886		Richards, William, B.Sc., The Clock House, Tooting, S.W.
Feb. 17, 1898		Richards, William, Old Elvet, Durham
June 18, 1885	Trans.	Richardson, Arthur, 37, Hornby-row Fort, Bombay
Feb. 16, 1888	Trans.	Richardson, Clifford, Laboratory, Barber Asphalte Co., Long Island City, New York, U.S.A.
Feb. 1, 1883		Richardson, F. W., 2, Farcliffe-place, Bradford
Mar. 6, 1873		Richardson, Henry, Lyndene, Hale-road, Bowdon, Cheshire
Dec. 6, 1888		Richardson, Hubert N. B., 10, Friar-lane, Leicester
April 19, 1866		Richardson, Joseph, jun., 40, Warwick-road, Chorlton-cum-Hardy, Manchester
Dec. 1, 1864		Richardson, J. G. F., Ph.D., Elmfield, Knighton, Leicester
May 5, 1892		Richardson, Reginald E. S., Elmfield, Knighton, Leicester
Nov. 17, 1887		Richardson, W. H., Dudley
Mar. 3, 1887	Trans.	Richmond, H. Droop, Rodbourne, Claremont-road, Twickenham
Feb. 3, 1845		Rickard, W. T., 136, Maygrove-road, West Hampstead, N.W.
Dec. 6, 1894		Riddick, D. G., Stores Department, G.E.R., Stratford, E.
Dec. 7, 1882	Trans.	Rideal, Samuel, D.Sc., F.I.C., 28, Victoria-street, Westminster, S.W.
April 3, 1873		Rider, Alonzo John, 4, Haddington-road, Stoke, Devonport
Dec. 5, 1895		Ridge, W. T. B., 2, Ashwood-terrace, Longton, Staffs.
Feb. 16, 1882	Trans.	Ridsdale, C. H., Hutton-grange, Guisbrough, Yorks.
Dec. 6, 1888		Rigby, John S., 26, Bagot-street, Wavertree, Liverpool, and Ditton, Lancashire
Dec. 15, 1851	Trans	Riley, Edward, 14A, Finsbury-square, E.C.

Date of Election.		
May 4, 1893		Rintoul, William, Royal Gunpowder Factory, Waltham Abbey
June 15, 1893		Ritchie, George, "Hailey," Mount Vernon, N.B.
May 4, 1893		Robbins, James H., 4, Selborne-road, Ilford
April 13, 1872		Robbins, John, 57, Warrington-crescent, Maida-vale, W.
Dec. 2, 1897		Roberts, E. H., 13, Belle Vue Gardens, Allfarthing-lane, Wandsworth, S.W.
June 21, 1883		Roberts, Frederick G. Adair, Chemical Works, Stratford, E.
Jan. 20, 1876		Roberts, Martin Fenn, Postal Telegraph Factory, Mount Pleasant, Clerkenwell, E.C.
April 4, 1889		Roberts, R. Wightwick, c/o A. W. Rowe, Esq., Dashwood House, 9, New Broad-street, E.C.
May 3, 1894		Roberts, Thos. John, 31, North-road, St. Helens, Lancs.
Feb. 19, 1880		Roberts, W. Brittain, Wilderspool House, Warrington, Lancashire
Nov. 7, 1866	Trans.	Roberts-Austen, William Chandler, C.B., F.R.S., Royal Mint, E.
Feb. 15, 1894		Robertson, A. B., Struan, Lugar-street, Coatbridge, N.B.
Mar. 17, 1887		Robertson, George, London Hospital, E., and Madeira-villa, Woodford Green, Essex
Dec. 4, 1890	Proc.	Robertson, George Henry,
Feb. 21, 1889		Robins, Harry H., Messrs. Southwell and Co., Dockhead, S.E.
May 5, 1881		Robinson, G. Carr, Royal Institution, Hull
Nov. 16, 1882	Trans.	Robinson, Henry H., M.A., Wuchang, Hankow, China
May 7, 1896		Robinson, H. F., B.Sc., Sparthfield, Droylsden-road, Newton-leath, Manchester
Feb. 21, 1895		Robinson, H. Lewin, Chemical Laboratory, Vickers, Sons, and Maxim, Ltd., Erith, Kent
May 3, 1866		Robinson, John, 2, Ornan-mansions, Hampstead, N.W.
Dec. 15, 1892	Trans.	Robson, James, Andersonian-buildings, 204, George-st., Glasgow
Dec. 20, 1883		Rogers, Arthur W., Tadcaster Tower Brewery Co., Tadcaster
Jan. 17, 1884		Rogers, Francis M., 21, Burma-road, Stoke Newington, N.
June 7, 1894		Rolfe, John F., 18, Victoria-street, Clayton-le-Moors, Lancashire
April 15, 1886		Roose, Robson, M.D., 45, Hill-street, Berkeley-square, W.
Dec. 17, 1855	Trans.	Roscoe, Sir H. E., LL.D., D.C.L., Ph.D., F.R.S., 10, Bramham-gardens, South Kensington, S.W.
Feb. 19, 1891	Trans.	Rose, Tom Kirke, D.Sc., 9, Royal Mint, E.
June 18, 1896		Rosenblum, S. G., F.I.C., Imperial Chambers, Cursitor-street, E.C.
May 7, 1896	Trans.	Rosenheim, Otto, Ph.D., 68, Belsize-park-gardens, N.W.
Mar. 4, 1897		Rosling, Edward, Melbourne, Chelmsford
Feb. 15, 1894		Ross, Arthur, 1, Glengall-road, Old Kent-road, S.E.
Feb. 17, 1870		Ross, Lewis Buttle, Driffild, Yorks.
Dec. 15, 1881		Ross, Rev. Henry, LL.D., Dallas House, Lancaster
May 7, 1896		Ross, R. St. G., 5, Lavender-road, Worcester
June 18, 1891	Proc.	Rossiter, Edmund Charles, Sunnyside, Vicarage-road, Langley, Birmingham

Date of Election.

Feb. 20, 1896		Rostron, H., B.Sc., 70, Davenport-street, Bolton
Feb. 18, 1892		Rothewell, C. F. Seymour, 2, St. Mary's-street, Manchester
Dec. 5, 1895		Round, W., 100, Bagot-street, Birmingham
Feb. 15, 1894		Rowntree, Walter Smithson, B.Sc., Sidcot School, Somerset
Mar. 20, 1862	Trans.	Royle, Thomas, 329, Upton-lane, Forest Gate, E.
Feb. 15, 1872		Ruffle, John, Hope Cottage, Trinity-road, Ware
Dec. 5, 1895		Rugginz, W. A., "Strathmore," 14, Empress-avenue, Cranford Park, Ilford
Jan. 17, 1889	Trans.	Ruheman, Siegfried, Ph.D., M.A., Gonville and Caius College, Cambridge
Feb. 15, 1883		Rumble, Charles, 9, Sangora-road, New Wandsworth
Feb. 6, 1890		Russell, Edward, 35, Southeby-road, Highbury Park, N.
Dec. 3, 1896		Russell, William, c/o The Gold and Silver Extraction Co., Limited, 208-210, McPhee Buildings, Denver, Colorado, U.S.A.
Mar. 3, 1851	Trans.	Russell, W. J., Ph.D., F.R.S., 34, Upper Hamilton-terrace, St. John's-wood, N.W.
Feb. 20, 1896		Rutter, T. F., B.Sc., The Municipal Technical School, Birmingham
June 7, 1894		Ryce, George, B.A., Agricultural College, West Lavington, Wilts.
Feb. 16, 1870		Rylands, Thomas Glazebrook, F.L.S., Highfields, Thelwall, near Warrington
June 7, 1888		Sach, A. J., Technical School, Goulburn, N.S.W.
June 18, 1868		Sadler, S. A., Dr., Cleveland Chemical Works, Middlesborough
May 4, 1882		Sadtler, Samuel P., Ph.D., 145, North 10th-street, and 1042, Drexel-buildings, Philadelphia, U.S.A.
Feb. 20, 1896		Sage, C. E., 8, Fisher-street, Red Lion-square, W.C.
April 21, 1898		St. John, Harry, Thornfield, Sunderland
June 19, 1879	Trans.	Sakurai, J., Science College, Imperial University, Tokyo, Japan
Feb. 19, 1880		Salamon, Alfred Gordon, 27, Holland-park, W.
May 4, 1876		Salomons, Sir David Lionel, Broomhill, Tunbridge Wells; and Berkeley Chambers, 13, Bruton-street, Hyde-park, W.
April 16, 1863		Salt, Henry, M.D.C.M., F.R.G.S., Inglewood, Great Malvern
Feb. 17, 1859		Salter, Thomas W., 15, Belle Vue, West-hill, Hastings
June 25, 1871		Salter, Mortyn John, Northcote, Beaconsfield-road, New Southgate
Feb. 20, 1896		Salt, A. P., Sunnyside, Pinner-road, Harrow
May 4, 1882		Samuel, W. Cobden, Wilton Lodge, 337, Norwood-road, West Norwood, S.E.
Mar. 3, 1870		Sandberg, C. P., Palace-chambers, 9, Bridge-street, Westminster
Feb. 18, 1892		Sandercock, Thos. J. Buckler, Sidecup College, Sidecup, Kent
Dec. 6, 1888		Sanderson, John, P.O. Box 84, Middlesborough, Kentucky, U.S.A.
Nov. 16, 1882		Sanford, P. Gerald, Laboratory, 20, Cullum-street, E.C.
Dec. 4, 1890		Saniter, Ernest Henry, Queen's-terrace, Seaton Carew

Date of Election.		
Dec. 3, 1891		Sanyal, Abhayacharan, M.A., Professor of Physical Science, Queen's College, Benares, N.W.P., India
Dec. 15, 1892		Sarbadhicary, Satya-prasad, 1, College-street, Calcutta
June 17, 1886		Saunders, Prof. William, Experimental Farm, Ottawa, Ontario, Canada
Dec. 3, 1896		Saville, A. E., Gasworks, Holyhead
Feb. 17, 1898		Sayer, H. C., 37, Summerhill-road, Dartford
Feb. 6, 1890		Sayers, William Charles, 63, High-street, Lewisham, S.E.
Dec. 3, 1885		Scammell, Luther R., 42-4, King William-street, Adelaide, South Australia
June 21, 1877		Scarf, Sydney Isaac, F.I.C., City of London College, White-street, Moorfields, E.C.; and 75, Oxford-road, Islington, N.
June 17, 1897		Scargill, L. W. K., B.A., 14, Brunswick-place, West Brighton
Dec. 7, 1893	Trans.	Schidrowitz, Philip, Ph.D., 57, Chancery-lane, W.C.
Dec. 6, 1888		Schieffelin, William Jay, 840, Southern-boul., New York, U.S.A.
Dec. 15, 1892	Trans.	Schloesser, Augustus, Ph.D., Storey Institute, Lancaster
Feb. 18, 1892		Schofield, James Alexander, University of Sydney, New South Wales
Mar. 15, 1842	Trans.	Schunck, Edward, Ph.D., F.R.S., Oaklands, Kersal, Manchester
Feb. 20, 1896		Scotland, P. B., Airdrie Academy, Airdrie, N.B.
Dec. 18, 1879	Trans.	Scott, Alexander, M.A., D.Sc., F.R.S., Davy-Faraday Research Laboratory, 20, Albemarle-street, W.
April 17, 1890		Scott, Ernest George, 67, Lord-street, Liverpool
Mar. 3, 1887		Scrutton, W., 18, Billiter-street, E.C.
Mar. 1, 1883	Proc.	Scudder, Frank, 44, Mosley-street, Manchester
Dec. 3, 1896		Seabrooke, H. C., Laboratory, The Brewery, Reading,
May 7, 1891		Searl, Albert, Montreux, Victoria-road, Sidcup
Nov. 20, 1890		Seaton, Edward C., M.D., The Limes, 56, North Side, Clapham Common, S.W.
June 21, 1888		Seely, Herbert W., 11, Corn-market, Halifax
Dec. 15, 1892	Trans.	Sell, William James, M.A., Univ. Chem. Laboratory, Pembroke-street, Cambridge
April 15, 1875		Sellon, J. Scudamore, The Hall, Sydenham, S.E.; and 78, Hatton-gardens, E.C.
Mar. 4, 1875	Trans.	Senier, Alfred, Prof., M.D., Ph.D., Queen's College, Galway
June 21, 1887		Senier, Harold, Braybrook Lodge, Harrow
June 15, 1893		Sessions, Wilfred, B.Sc., 46, Neuenheimer Landstrasse, Heidelberg, Germany
May 7, 1896		Severn, W. D., West End Pathological Laboratory, 55, Weymouth-street, W.
Jan. 20, 1870	Trans.	Seward, Henry, c/o Messrs. J. B. Freeman, Sons, and Co., Wandle Colour Works, Wandsworth, S.W.
Feb. 19, 1874		Sexton, A. Humboldt, F.I.C., F.R.S.E., Professor of Metallurgy,

Date of Election.

		Metallurgical Department, Andersonian-buildings, 204, George-street, Glasgow
Dec. 5, 1895		Seyler, C. A., B.Sc., 31, Windsor-terrace, Swansea
June 20, 1880		Shadwell, J. E. L., Meadowbanks, Melksham, Wilts
Feb. 20, 1873		Shapleigh, Waldron, Welsbach Incandescent Gas Light Co., Factory, Gloucester City, New Jersey, U.S.A.
Dec. 7, 1893		Shapley, Frederick, c/o Messrs. L. Bergen and Sons, 248, Front-street, New York
June 4, 1874		Sharman, William, 186, Mare-street, Hackney, N.E.
June 18, 1885		Sharp, James, The Towers, Low Moor, near Bradford
Feb. 21, 1895		Sharrott, T. C., Chestnut House, Tamworth
Dec. 15, 1892		Shaw, G. Arthur, 45, St. Petersgate, Stockport
May 16, 1895	Trans.	Shaw, G. E., 9, Basing-road, Westbourne-park, W.
Feb. 6, 1890	Trans.	Shaw, Saville, M.Sc., Durham College of Science, Newcastle-upon-Tyne
June 16, 1887		Sheard, John T., Birley Mount-villas, Wadsley-bridge, near Sheffield
April 4, 1889		Shegog, Thomas Alexander, 28, Omsbersley-road, West Park, Newport, Mon.
Feb. 17, 1876	Trans.	Shenstone, W. A., F.R.S., Clifton College, Bristol ; and Glenfarg Villa, Percival-road, Clifton, Bristol
June 17, 1897		Shenton, J. P., 34, Lansdowne-road, West, Didsbury, Manchester
May 21, 1874		Shepherd, H. H. B., Northcote, Mount Pleasant-lane, Upper Clapton, N.E.
June 18, 1891	Trans.	Shields, John, Ph D., D.Sc., 79, Balmoral-road, Willesden Green, N.W.
Dec. 3, 1896		Shimomura, Kotaro, Prof., c/o Sekijen Ginks, 61, Imabashi Shichome, Osaka, Japan
June 7, 1894		Shorthouse, H. S., 47, Pershore-road, Birmingham
Nov. 18, 1886		Shutt, Frank T., M.A., Experimental Farm, Ottawa, Canada
April 17, 1890		Shuttlewood, W. Brewin, 8, Clifton-road, Crouch End, N.
June 7, 1894		Shuttleworth, E. B., Prof., 220, Sherborne-street, Toronto
Dec. 15, 1859		Sibson, Alfred, 23, St. Mary Axe, E.C.
May 16, 1889		Sibson, Alfred Edward, 1, Maple-villas, Palmerston-road, Buck-hurst Hill, Essex
Nov. 29, 1874	Trans.	Siebold, Louis, Broomville-avenue, Sale, near Manchester
Dec. 2, 1886		Silvester, Harry, 78, Holyhead-road, Handsworth, Birmingham
Dec. 3, 1885		Sim, James, 6, Carden-terrace, Aberdeen
April 4, 1889		Simmonds, Henry, Engineer's Office, Gas Works, Bury, Lancashire
April 21, 1887		Simmons, L. Owen, 64, Somerleyton-road, Brixton, S.W.
June 20, 1895		Simons, A. J., c/o M. Simons, Esq., 31, Little Britain, E.C.
Feb. 20, 1896		Simpson, A. M., 4, Kitto-road, St. Catherine's-park, S.E.
Dec. 2, 1897		Simpson, E. S., B.E., 34, Pier-street, Perth, W.A.

Date of Election.

1857	Trans.	Simpson, Maxwell, M.D., F.R.S., 9, Barton-street, West Kensington
May 29, 1886		Simpson, William Selby, Halcyon House, Private-road, Enfield
May 16, 1889		Singer, Ignatius, G.P.O., Wellington, N.Z.
Feb. 20, 1896		Sircar, Amrita Lal, 51, Sankaritola, Calcutta
April 15, 1880		Skelton, J. R., Idle Hour, Thorpe St. Andrew, Norwich
Feb. 2, 1888	Trans.	Skinner, Sidney, M.A., The Cavendish Laboratory, Cambridge
Feb. 18, 1892		Skurray, Thomas, United Breweries, Abingdon, Berkshire
April 17, 1879		Slater, Charles, 81, St. Ermin's-mansions, Westminster
April 15, 1880	Trans.	Slater, Harold H., Havelock-villa, St. James's-road, Gravesend
Dec. 5, 1878		Slatter, George W., A.R.C.S., F.I.C., 12, Bromley-street, Shipley, Yorkshire
May 16, 1895		Slocum, F. L., Linden-avenue Corner, Reynolds-street, Pittsburgh, Pa.
Feb. 5, 1863	Trans.	Smee, A. Hutchinson, The Grange, Hackledge, Carshalton, Surrey
Dec. 16, 1875		Smetham, Alfred, Analytical Laboratory, Cereal Chambers, 16, Brunswick-street, Liverpool
June 21, 1883		Smith, Adolphe, 4, Barclay-road, Walham Green
April 17, 1890	Trans.	Smith, Alexander, Ph.D., B.Sc., Univer. Chicago, Chicago, U.S.A.
Feb. 16, 1888		Smith, Angus, 10, Ardgowan-street W., Greenock, N.B.
Dec. 15, 1881	Trans.	Smith, Bernard E., 48, Percy-park, Tynemouth
Dec. 6, 1894	Trans.	Smith, Claude, Fernside, Haveringatte Bower, Romford, E.
Feb. 21, 1884		Smith, Edgar Francis, 35, Amptill-square, Hampstead-road, N.W.
Dec. 9, 1869		Smith, Edward, Dukes, Bradninch, near Cullompton, Devon
June 7, 1894	Trans.	Smith, Ernest A., Metallurgical Laboratory, Royal College of Science, South Kensington
Nov. 20, 1892		Smith, Fred., P.O. Box 1324, Johannesburg, S.A.R.
April 2, 1874		Smith, George, Nobel's Explosives Co., Polmont Station, Scotland
Dec. 20, 1883		Smith, George, 282, Friern-road, East Dulwich, S.E.
June 18, 1896		Smith, G. E. Scott, 67, Surrey-street, Sheffield
Feb. 18, 1892		Smith, George P. Darnell, 80, Woodland-road, Tyndall's-park, Bristol
Feb. 20, 1896		Smith, H. G., The Technological Museum, Sydney
Feb. 6, 1890		Smith, Harry Wood, B.Sc., The British Cyanides Co., Ltd., Oldbury
Mar. 16, 1878		Smith, H. R., 1, Aubert-park, Highbury, N.
May 5, 1892		Smith, John Meadows, Laboratory, 66, College-street, Chelsea, S.W.
Dec. 2, 1897		Smith, R. F. Wood, 89, Bartholomew Close, E.C.
Feb. 19, 1891		Smith, R. Greig, M.Sc., Linnean Society's House, Elizabeth Bay, Sydney, N.S.W.

Date of Election.

Feb. 16, 1888		Smith, Sam, 15, Springfield-road, Swindon
Nov. 18, 1886		Smith, Sidney, 35, Amptill-square, Hampstead-road, N.W.
April 21, 1898		Smith, T. D., B.A., Eastbourne College, Eastbourne
Feb. 3, 1876		Smith, W. A., M.A., M.B. Oxon, M.R.C.S. Eng., Newport, Essex
Dec. 20, 1866	Trans.	Smith, Watson, 34, Upper Park-road, Haverstock Hill, N.W.
Dec. 20, 1883	Trans.	Smithells, Arthur, Prof. B.Sc., The Yorkshire College, Leeds
Dec. 18, 1873		Smyth, John, M.A., Milltown, Bantridge, Ireland
Mar. 3, 1887	Trans.	Snape, Henry Lloyd, Prof., D.Sc., Ph.D., Chemical Laboratories, University College of Wales, Aberystwith
Dec. 3, 1896		Sodeau, W. H., B.Sc., 25, Shore-road, South Hackney, N.E.
Feb. 3, 1887		Sohn, Charles E., F.I.C., 22, Southampton-row, W.C.
June 18, 1891		Solomon, Frank Oakley, 36, St. Mary's-place, Newcastle-on-Tyne
Dec. 17, 1874	Trans.	Sonstadt, Edward, Church Field, Cheshunt, Herts
Dec. 18, 1884	Trans.	Sorabji, Bomanji, Khan Bahadur, Ph.D., C.E. (Bombay) Assoc., M.I.C.E. (Lond.)
June 15, 1893		Sorrell, Henry Thomas, Holly Lodge, Millbrook-road, Southampton
May 6, 1875		Southall, Alfred, Garrick House, Richmond Hill, Edgbaston
Mar. 4, 1897		Southerden, Frank, 75, Barry-road, Dulwich, S.E.
Dec. 2, 1897		Southern, Thomas, jun., Wheat Hill Chemical Works, near Broughton Bridge, Manchester
June 21, 1883		Soward, Alfred W., 28, Therapia-road, Honor Oak, S.E.
Dec. 15, 1892		Spackman, Charles, Rosehaugh, Clitheroe, Lancashire
Feb. 21, 1889		Speakman, James, Penhold, Post Office, Calgary, Alberta, Canada
Feb. 1, 1883		Spencer, Ernest Samuel, Arborfield, Wimbledon Park
April 4, 1878		Spencer, James, B.Sc., 38, Ash-grove, Bradford
Mar. 4, 1886		Spencer, Richard, 46, Warwick-street, Barrow-in-Furness
Feb. 6, 1879		Spencer, Samuel,
June 16, 1887		Spencer, W. Shelley, Lyndene, Darley, Farnworth, near Bolton
June 7, 1894		Spenser, John George, M.D., Ph.D., Prof., Western Reserve University, 370, Central-avenue, Cleveland, Ohio, U.S.A.
Feb. 3, 1859	Trans.	Spiller, John, 2, St. Mary's-road, Canonbury, N.
Jan. 15, 1863		Spiller, William, Atlas Dye Works, Hackney-wick, E.
June 18, 1885		Spilsbury, James, Mayfield, Mayfield-road, Moseley, Birmingham
April 21, 1898	Trans.	Spivey, W. T. N., M.A., 5, Trumpington-street, Cambridge
June 4, 1885		Spottiswoode, W. Hugh, Balliol College, Oxford; and 6, Middle New-street, E.C.
Feb. 18, 1892		Spray, Henry John, c/o Messrs. Hopkins and Williams, Bridge-fields, Wandsworth, S.W.
Dec. 1, 1864	Trans.	Sprengel, Hermann Johann Philipp, Ph.D. (Heidelb.) F.R.S., Royal Prussian Professor (titular), Savile Club, 107, Piccadilly, W.
Mar. 16, 1895		Squance, T. C., M.D., M.S., L.S.Sc., F.R.M.S., F.R.M.St. S., 15, Grange-crescent, Sunderland

Date of Election.

May 4, 1882		Squire, P. Wyatt, 413, Oxford-street, W.
Feb. 4, 1858	Trans.	Squire, W. Stevens, Ph.D., Clarendon House, St. John's Wood-park, N.W.
Feb. 18, 1892		Squires, Alfred James, 84, Derby-road, Farnworth, Widnes, Lancs.
May 5, 1892		Stables, William Herbert, Rev., B.A.
June 21, 1877		Stacey, Henry George, 300, High Holborn, W.C.
Mar. 4, 1897		Stainer, W. J., B.A., Charlesville, Beaconsfield-road, Widnes, Lancs.
Dec. 18, 1879	Trans.	Stallard, George, M.A., Horton Crescent, Rugby
April 21, 1859	Trans.	Stanford, Edward Charles, Glenwood, Dalmeir, Dumbartonshire
Mar. 17, 1887		Stanger, W. Harry, Chemical Laboratory, Broadway, Westminster
Feb. 3, 1887		Stansell, Lionell W., 4, Albion-place, Maidstone, Kent
May 16, 1895		Stansfield, A., B.Sc., Aldersyde, Hainault-road, Leytonstone
Dec. 3, 1885		Staples, Henry J., Spondon, Derby
Dec. 15, 1870		Starey, Arthur J., 18, Ashley-road, Hornsey-rise, N.
Dec. 15, 1870	Trans.	Stark, J. Fleming, 31, Highfield South, Rock Ferry, Birkenhead
Mar. 16, 1876		Starling, J. H., 32, Craven-street, Strand, W.C.
May 7, 1896		Stead, J. C., Mitre Chemical Works, Cordova-road, Bow, E.
Nov. 16, 1882	Trans.	Stead, J. E., 11, Queen's-terrace, Middlesborough
May 4, 1882		Stebbins, James H., jun., Ph.D., 114, Pearl-street, New York
Dec. 2, 1897		Steel, F. W., Tamunua, Navua River, Fiji
May 7, 1885		Steel, Robert Elliot, County School, Northampton
June 7, 1894		Steel, Robert W., Wedderburn, Paisley
Dec. 5, 1889		Steel, Sydney, 26, Somerset-street, Portman-square, W.
Dec. 4, 1890		Steel, Thomas, c/o Colonial Sugar Refining Co., Sydney, N.S.W.
Dec. 18, 1884		Steele, Robert, 8, Adelaide-square, Bedford
May 5, 1892	Trans.	Stenhouse, James, Elm-row, Lasswade, Midlothian, N.B.
Jan. 17, 1884		Stenhouse, Thomas, Townhead, Rochdale
Dec. 5, 1895	Trans.	Stephens, F. R., c/o Messrs. Idris, Pratt-street, Camden Town, N.W.
April 15, 1880		Stephens, Henry Charles, M.R. Inst., Avenue House, Finchley
Dec. 2, 1897		Stephens, M. E., Avenue House, Finchley, N.
Feb. 21, 1895		Stephenson, Herbert F., 14, Gap Road, Wimbledon, S.W.
Dec. 3, 1885		Stephenson, Stephen, 98, Kensington, Liverpool
Dec. 3, 1891	Trans.	Stephenson, Thomas, Victoria House, Byculla, Bombay
Dec. 6, 1888	Trans.	Stern, Arthur Landauer, D.Sc., F.I.C., 170, Ashby-road, Burton-on-Trent
Dec. 15, 1881		Steuart, Daniel Rankin, Osborne Cottage, Broxburn, Linlithgow-shire
June 18, 1896		Steuart, D. Stuart Spens, B.Sc.
Mar. 4, 1897	Trans.	Stevens, H. P., B.A., 169, Queen's Gate, S.W.
Feb. 18, 1864		Stevenson, Thomas, M.D., Guy's Hospital, S.E.
Feb. 6, 1879		Stevenson, William, 95A, Southwark-street, S.E.
June 20, 1872		Stewart, Walter, 1, Murrayfield-gardens, Edinburgh

Date of Election.

June 21, 1866		Stock, W. F. K., 5, Dixon-terrace, Darlington
June 18, 1874		Stocks, Frederic, Snead's Green House, Droitwich, Worcestershire
Nov. 17, 1887		Stocks, Herbert B., c/o Messrs. Day and Martin, Borough-road, S.E.
May 3, 1894		Stoddart, Frederick Wallis, Grafton Lodge, Sneyd Park, Bristol
April 17, 1879	Trans.	Stokes, A. W., Vestry Hall, Paddington
Dec. 18, 1873		Stone, Edward Daniel, Rose Lea, Alderley Edge, Cheshire
April 17, 1890		Stone, Frederick Richard M., 58, Upper Parliament-street, Liverpool
Dec. 5, 1895		Stone, George, Standard Brewery, Sydney, N.S.W.
Dec. 2, 1875		Stone, J. Harris, M.A., F.L.S., Barrister-at-law, 4, Temple, E.C.
April 17, 1879		Stone, William, M.A. (Cantab), F.L.S., Oxford and Cambridge, Garrick, and Union Clubs, and D 6, The Albany, Piccadilly
May. 7, 1891		Storey, James Ashburner, B.Sc., Igalkanda estate, Elpitiya, Ceylon
June 19, 1884		Stornmouth, Thomas, Athol House, Clarence-road, St. Thomas, Exeter
Feb. 3, 1887		Strangman, J. Pim, 38, Rue Desbordes, Valmore, Paris-Passy
May 7, 1885	Trans.	Stuart, Charles M., M.A., St. Dunstan's College, Catford, S.E.
Dec. 2, 1897		Stubbs, George, Arnside, Hertford-road, East Finchley, N.
Dec. 7, 1893		Styles, R. Curling, Knockhall, Greenhithe, Kent
Dec. 4, 1890	Trans.	Sudborough, J. Joseph, Ph.D., D.Sc. University [College, Nottingham
Dec. 5, 1878	Trans.	Suguiru, Shigetake, c/o Tokio Chemical Society, Imagawakoji 1, Tokio, Japan
Mar. 4, 1897		Sumner, Leonard, B.Sc., Butt Hill, Prestwich, near Manchester
Feb. 3, 1887		Sutherland, D. A., F.I.C., 28, Victoria-street, Westminster, S.W.
Feb. 21, 1884		Sutton, C. W., 19, Henley-road, Ipswich
April 19, 1860		Sutton, F., Laboratory, Bank Plain, Norwich
Mar. 4, 1886		Sutton, F. Napier, 6, Grosvenor-gardens, Willesden Green
June 3, 1875		Swan, Joseph Wilson, M.A., F.R.S., 58, Holland-park, W.
June 20, 1889		Swan, Robert M. W., 15, Walmer-crescent, Glasgow
May 3, 1894		Swinburne, James, 66, Victoria-street, S.W.
Dec. 5, 1889		Sworn, Sidney Augustus, M.A., The New Municipal Technical School, Gravesend
Feb. 18, 1892		Sykes, James, 76, Lockwood-road, Huddersfield
Feb. 19, 1891		Sykes, M. Carrington, L.P.H. Lond., L.R.C.P. Lond., M.R.C.S. Eng., L.S.A. Lond., Sykeshurst, Barnsley, Yorks.
May 16, 1889		Sykes, Walter J., M.D., 59, Friend's-road, Croydon
Feb. 19, 1891		Symes, K. Edward, 95, Lodge-road, The Avenue, Southampton
June 17, 1880		Symons, Brenton, 5, Kew Gardens-road, S.W
Dec. 17, 1874	Trans.	Symons, William Henry, M.D. (Brux.), D.P.H. (Oxon.), M.R.C.S. Eng., F.I.C., Medical Officer of Health's Department, Guildhall, Bath

Date of Election.

Feb. 17, 1881	Trans.	Takamatsu, T., Engineering College, Imperial University, Tokio, Japan
Feb. 3, 1887	Trans.	Takamine, Jokichi, 6641, Woodlawn-avenue, Chicago, U.S.A.
Feb. 15, 1894		Tanner, Alf. E., Westminster Hospital, S.W.
Dec. 4, 1890		Tate, Francis Henry, 9, Hackins Hey, Liverpool
June 16, 1881	Trans.	Tate, George, Ph.D., 11 and 12, London and Lancashire Chambers, 45A, Dale-street, Liverpool
Dec. 18, 1884		Tate, Walter, The Woodlands, Tiverton-on-Avon, Bath
May 15, 1890		Tate, William, Civil Engineering College, Sibpur, Calcutta
Dec. 5, 1867		Tatlock, Robert R., Novara, Stirling
June 17, 1897		Taverner, William, 1, Stapenhill-road, Burton-on-Trent
Dec. 6, 1894		Taylor, Albert, Technical School, Stockport
Dec. 2, 1875		Taylor, Andrew, 11, Lutton-place, Edinburgh
Dec. 7, 1882		Taylor, G. Midgley, 27, Great George-street, Westminster
June 7, 1894		Taylor, Herbert J., 9, Portland-villas, Bath-street, Dewsbury
June 17, 1880		Taylor, James, B.Sc., Government metallurgical works, Clyde, New South Wales
June 18, 1891		Taylor, John, 15, Lucius-street, Torquay
April 19, 1888		Taylor, John G., 16, Trinity-street, Stockton-on-Tees
Jan. 15, 1874	Trans.	Taylor, R. L., 37, Mayfield-road, Whalley Range, Manchester
Dec. 6, 1888		Taylor, William, China Sugar Refining Co., East Point, Hong Kong
April 4, 1878		Tcherniac, Joseph, Ph.D., Thalstrasse 1, Freiburg, Briesgau, Germany
April 17, 1879	Trans.	Teed, Frank L., D.Sc., 15, Victoria-street, S.W.
May 1, 1877		Terrill, William, 42, St. George's-terrace, Swansea
May 3, 1894		Terry, Edwin, 374, Brixton-road, S.W.
Feb. 15, 1881		Tervet, Robert, 54, Penshurst-road, South Hackney, E.
Feb. 16, 1893		Thackrah, James R., M.A., Ph.D., Technical Schools, Tavistock-road, Plymouth
May 16, 1895		Theodosius, A. F., B.A., University College, Oxford
Nov. 17, 1859		Thomas, Andrew, c/o M. C. Neville, Esq., 9, Hendley-street, Adelaide, South Australia
Dec. 7, 1871		Thomas, Charles, Stoke Bishop, nr. Bristol
Mar. 5, 1874		Thomas, Harry E., Rockleaze Point, Clifton, Bristol
Feb. 18, 1875	Trans.	Thomas, Joseph William, 2, Hampstead Hill Mansions, N.W.
Feb. 5, 1863		Thompson, Beeby, 55, Victoria-road, Northampton
Dec. 3, 1896		Thompson, Charles, B.Sc., Grammar School, Coatham, Redcar
Mar. 4, 1886	Trans.	Thompson, Claude M., Prof., D.Sc., M.A., University College, and 38, Park-place, Cardiff
June 7, 1894		Thompson, Edward Cumming, 48, Kestrel-avenue, Herne Hill, S.E.
June 15, 1893		Thompson, Frank Ernest, 58, Brook-street, Stourbridge
May 4, 1893		Thompson, George R., The Laboratory, 57, Dock-street, Newport, Mon.
Mar. 4, 1897		Thompson, Harry, Chemical Laboratory, 5, Bishop-lane, Hull

Date of Election.

Dec. 16, 1886		Thompson, W. Phillips, 95, Shrewsbury-road, Claughton, Birkenhead
Dec. 17, 1885	Trans.	Thomson, Andrew, D.Sc., 10, Pitcullen-terrace, Perth
Nov. 2, 1876		Thomson, George C., 4, The Green, Bromborough Pool, near
April 15, 1858	Trans.	Thomson, John, Gwydor-villa, Elmers End, Beckenham
Jan. 18, 1872	Trans.	Thomson, John Millar, Prof., LL.D., F.R.S., King's College, W.C.; and 85, Addison-road, W.
Jan. 18, 1872		Thomson, William, Royal Institution Laboratory, Manchester
May 16, 1895		Thomson, W. T., Offord-villas, Waltham Abbey
May 7, 1891		Thonger, C. G. Freer, M.R.A.C., Colonial College, Hollesley Bay, Suffolk
Feb. 16, 1882	Trans.	Thorne, Leonard T., Ph.D., 8, Dynevor-road, Richmond
Nov. 20, 1890		Thornley, J. Brooks, jun., c/o Felton, Grimwash, and Co., Jeffcott-street, Melbourne, Australia
May 16, 1895		Thornton, A., M.A., 67, St. Mary's-terrace, Manningham
Dec. 3, 1891		Thorp, Walter, B.Sc., Analytical Laboratory, Limerick
Feb. 1, 1866	Trans.	Thorp, William, B.Sc., 22, Sinclair-gardens, West Kensington
Dec. 7, 1893	Trans.	Thorpe, Jocelyn Field, Ph.D., Owen's College, Manchester
Feb. 16, 1871	Trans.	†Thorpe, T. E., Ph.D. (Heid.), B.Sc. (Vict.), D.Sc. (Dubl.), LL.D. (Glas.), F.R.S., Government Laboratory, Clements Inn Passage, W.C.
June 7, 1894		Thudichum, George Dupré, 2, Salcombe-villas, Kingston-road, Merton Park, Wimbledon
Dec. 20, 1880	Trans.	Thudichum, John L. W., M.D., 11, Pembroke-gardens, W.
Dec. 2, 1860		Thwaite, B. H., 29, Great George-street, Westminster
Dec. 5, 1895		Tibbals, W. I., 93, Cass-street, Detroit, Mich., U.S.A.
Feb. 19, 1863	Trans.	Tichborne, C. R. C., Ph.D., 15, North Great George-street, Dublin
Mar. 6, 1897	Proc.	Tickle, Thomas, Herbert-villa, East-lane, Wembley, Middlesex
Mar. 17, 1881	Trans.	Tiemann, Ferdinand, Prof., Dr., Parkstrasse, Wannsee, by Potsdam
June 1, 1865	Trans.	Tilden, William A., D.Sc. (Lond.), D.Sc. (Dubl.), F.R.S., Prof. Royal College of Science, South Kensington; and 9, Ladbroke-gardens, W.
Dec. 5, 1889	Trans.	Tingle, J. Bishop, Ph.D., Lewis Institute, Chicago, Ill., U.S.A.
May 7, 1891		Tocher, James Fowler, A.I.C., 1, Chapel-street, Peterhead
Feb. 21, 1884	Trans.	Tompson, Frederick William, Crockham Hill, Edenbridge
June 21, 1877		Toms, Frederick Woodland, F.I.C., Official Analyst, Jersey
Jan. 15, 1855	Trans.	Tookey, Charles, Museum of Practical Geology, Jermyn-street, S.W., and Nelson's Hotel, Great Portland-street, W.
Dec. 3, 1868		Tosh, Edmund G., The Lund, Ulverston, Lancashire
Feb. 16, 1893		Towers, John William, Victoria-road, Widnes
Feb. 2, 1888		Townsend, Charles F., Basted Cottage, Ightham, near Sevenoaks
June 6, 1887		Traphagen, Dr. Frank W.,

† Longstaff Medallist, 1881.

Date of Election.

Feb. 18, 1892	Trans.	Travers, Morris W., B.Sc., 2, Phillimore-gardens, Kensington, W.
May 16, 1895		Treharne, F. G., Wrangbrook, Llanishen, near Cardiff
Feb. 15, 1894		Trench, George, Cotton Powder Co., Faversham
Mar. 15, 1888		Trewby, Herbert, 62, St. John Street, E.C.
June 16, 1881		Trigger, Oliver, Chemical Dept., Royal Arsenal, Woolwich
Dec. 2, 1897		Tripp, E. H., Ph.D., Kent House, Blackheath Hill, S.E.
Dec. 4, 1873		Truman, Edgar, M.D.,
Dec. 5, 1889		Tucker, Willis G., M.D., Medical College, Albany, New York, U.S.A.
May 7, 1896		Tuckett, J. E. S., M.A., Cantab, Eastbourne College, Eastbourne
May 5, 1892		Tuer, Arthur Holt, Thornhill, Wigan, Lancashire
Mar. 4, 1897		Turnbull, Andrew, Mason College, Birmingham
Dec. 2, 1886		Turner, Arthur, L.D.S. Ed., The Limes, Aylesbury
Feb. 20, 1896		Turner, B. B., B.Sc., Fräulein Scholte, Karspüle, 16 D. Göttingen, Germany
Mar. 4, 1897		Turner, B. W., c/o H. Turner, Esq., Collins Street, Annandale, Sydney, N.S.W.
Dec. 6, 1888		Turner, Charles, 225A, Oxford-street, Manchester
Dec. 2, 1897		Turner, J. S., 20, Bury-street, Bloomsbury, W.C.
Feb. 1, 1883	Trans.	Turner, Thomas, A.R.S.M., F.I.C., Ravenhurst, Rowley Park, Stafford
Feb. 21, 1889	Trans.	Turpin, George Sherbrooke, M.A. (Cantab), D.Sc. (Lond.), Schoolhouse, Swansea
Dec. 15, 1892		Turton, Albert H., Mount Lyell West, Mount Lyell, Tasmania
Feb. 2, 1871		Tustin, John Robt., F.R.G.S., Albion House, The Marina, Deal
Feb. 2, 1888	Trans.	Tutton, Alfred E., 17, Bardswell-road, Oxford
June 19, 1879		Tweedie, G. R., 8, Victoria-parade, East Cliff, Ramsgate
May 5, 1892		Tweedie, Thomas Shortridge, Trensano, Annan
Feb. 17, 1876		Typke, P. G. W., Ravenhurst, New Malden
Dec. 7, 1876		Tyrer, Thomas, Stirling Chemical Works, Abbey-lane, Stratford
Dec. 3, 1885		Tyson, Thomas B., 1, New China Bazaar-street, Calcutta
April 6, 1876		Udall, Thomas Bertram, Newcastle-under-Lyme, Staffordshire
Nov. 16, 1865		Umney, Charles, 50, Southwark-street, S.E.
Feb. 16, 1893	Trans.	Umney, John C., 50, Southwark-street, London, S.E.
Feb. 21, 1889		Underhill, Thomas J., 6, The Terrace, Royal Victoria Yard, Deptford, S.E.
Mar. 4, 1897		Unwalla, R. N., Medical Dept., Bhaunagar, Kathiawâr, India
Mar. 16, 1882		Vacher, Francis,
Mar. 6, 1890		Valentin, Basil William, Messrs. Buckley Bros., Brewery, Llanelly, S. Wales
Dec. 1, 1887		Vargas, Vergara J. M.,
Mar. 1, 1883		Vasey, S. A., Kingsthorpe, Lower Park, Loughton, Essex
Dec. 7, 1882		Vasey, Thomas E., P.O., Box 1149, Montreal, Canada

Date of Election.

June 15, 1893		Vautin, Claude T. J., 66, Old Broad-street, E.C., and 3, Upper Hamilton-terrace, N.W.
Dec. 6, 1894		Vaux, Cuthbert, 11, Thornhill-park, Sunderland
April 17, 1879	Trans.	Veley, Victor H., M.A., F.R.S., 22, Norham-road, and University Museum, Oxford
Feb. 19, 1891		Velling, F. W. De, B.A., High Grade Board School, The Boulevard, Hull
May 6, 1881		Venable, Frank P., Ph.D., Chapel Hill, North Carolina
Dec. 2, 1897		Viccajee, F. K., Hyderabad, Deccan, India
Jan. 18, 1872		Vincent, Charles W., F.R.S.E., F.C.S. of Berlin, Reform Club, Pall Mall, S.W., and Royal Institution, W.
Dec. 2, 1897		Vinter, P. J., M.A., King's School, Canterbury
Feb. 21, 1884		Voelcker, Edward William, 22, Tudor-street, Blackfriars, E.C.
Jan. 17, 1884		Voelcker, John A., Ph.D., 20, Upper Phillimore-gardens, Kensington, W.
April 4, 1889		Voss, Walter Arthur, 15, Nicholson-road, Addiscombe, Croydon
Nov. 19, 1885		Vulté, Hermann T., Ph.D., Barnard College, 119 St., and Boulevard, New York
Feb. 6, 1890	Proc.	Wade, John, B.Sc. (Lond.), Wyvenhoe, Purley, and Guy's Hospital, S.E.
Dec. 6, 1894		Wagner, W. G., Glyndhurst, Ealing Common, W.
April 17, 1884		Wainwright, J. Howard, Ph.D., 22, West 46th Street, New York City, U.S.A.
Feb. 16, 1893		Wait, Chas. E., Prof., University of Tennessee, Knoxville, U.S., N.A.
May 17, 1888		Wait, Frank Goodell, Geological Survey Department, Ottawa
May 6, 1897		Waite, W. H., B.A., Park-road, Halifax
Mar. 4, 1897		Walford, S. M., Oak-street, Woodley, Stockport
Feb. 16, 1893		Walke, Willoughby, 1st Lieut., Fort Monroe, Virginia, U.S., N.A.
Jan. 16, 1868		Walker, Maj.-Gen. Alexander, C.S.I., R.A.,
Mar. 17, 1881		Walker, Archibald, B.A., 8, Crown-terrace, Dowanhill, Glasgow
Feb. 17, 1898		Walker, A. J., B.A., Kilycadden Killygordon, Co. Donegal
June 7, 1894	Trans.	Walker, Chas. H. H., M.A., 16, Worcester-place, Oxford
Feb. 6, 1890	Trans.	Walker, James, Prof., D.Sc., 8, Windsor-terrace, Dundee
Feb. 2, 1865	Trans.	Walker, J. F., M.A., 45, Bootham, York; and Sidney Sussex College, Cambridge
April 17, 1890		Walker, James S. H., M.B., C.M., 56, Queen's-road, Aberdeen
Dec. 6, 1888		Walker, J. T. Ainslie, 2, Victoria-road, New Shoreham, Sussex
Mar. 4, 1897	Trans.	Walker, J. Wallace, M.A., Ph.D., University College, W.C.
Feb. 17, 1881		Walker, Robert William, Wicken Hall, New Hey, near Rochdale
April 21, 1898		Walker, Samuel, M.A., B.Sc., 126, Gilmore-place, Edinburgh

Date of Election.

April 17, 1879		Walker, Thomas Hatfield, 1, Picton-place, Newcastle-on-Tyne
Dec. 3, 1896		Walker, W. H., Stafford-street, Willenhall, Staffs.
June 4, 1884		Wallace, Prof. Robert, The University, Edinburgh
Dec. 5, 1878		Waller, Elwyn, Ph.D., 7, Franklin-place, Morristown, N.Y., U.S.A.
Mar. 3, 1887		Wallis, Henry Weston, 11, Probyn-road, Tulse Hill, S.W.
Mar. 1, 1883		Walmsley, R. Mullineux, D.Sc., Northampton Institute, St. John Street-road, Clerkenwell, E.C.
Dec. 6, 1888		Walrond, Edward Dalrymple, B.A., North Eastern Counties School, Barnard Castle, Durham
Mar. 20, 1884		Walton, Thomas Ulrick, B.Sc., F.I.C., Colonial Sugar Refinery Co., Sydney, New South Wales
April 21, 1864		Ward, George, Buckingham-terrace, Headingley, Leeds
May 16, 1895		Ward, G. J., Hallam Fields, Ilkeston
Dec. 3, 1891		Ward, Thomas Armistead, 15, Exchange-street, Blackburn
April 20, 1871		Ward, William, Sheffield Moor, Sheffield
Dec. 4, 1873		Warden, C. J. H., Prof., c/o Messrs. Grindley & Co., 55, Parliament-street, S.W.
May 20, 1875		Wardle, Sir Thomas, F.G.S., Leek, Staffordshire
Mar. 19, 1863	Trans.	Warrington, Robert, F.R.S., High Bank, Harpenden, St. Albans
June 15, 1893		Warrington, Edward A., Ph.D., F.I.C., 266, Castle-street, Dudley, Worcs.
Dec. 7, 1871		Warner, George Joseph, Halton Villa, Widnes
Dec. 6, 1894		Warren, W. L., 12, Westland-row, Dublin
Dec. 6, 1888		Warrick, Frederic Walmsley, 7, Portpool-lane, E.C.
Nov. 17, 1887	Trans.	Warrington, Arthur Walley, M.Sc., University Coll. of Wales, Aberystwith
Feb. 21, 1895		Warrington, T. C., 52, Regent's-road, Hanley, Staffs.
May 16, 1895		Warwick, A. W., Minah Mines, Wickes, Mont., U.S.A.
Nov. 16, 1882		Waterfall, Charles J., 4, Queen-square, Bristol
June 7, 1894		Waterfield, A. Swainson, Grammar School, Bromyard, Worcester
Dec. 6, 1894		Waterhouse, Robert, c/o Messrs. J. Fisher and Sons, Limited, Queen's-street, Bradford, Manchester
April 4, 1889		Waterhouse, Wm. John, B.Sc., Christ Church, Oxford
Mar. 15, 1888		Wates, Edward Arthur, Coromandel Gold Mg. Co., Oorgaum, Mysore
May 4, 1893		Watson, A. Forbes, St. James's Gate, Dublin
Mar. 5, 1885		Watson, Charles, Primitiva Gas Co., Buenos Ayres, Argentine Republic
Jan. 18, 1872		Watson, David, D.Sc., The Broughton Copper Works, Salford, Manchester, and Willow Bank House, Kersal Dale, Higher Broughton
June 16, 1887		Watson, Frederick Percy, 6 and 7, Bailgate, Lincoln
Mar. 1, 1883		Watson, Thomas Donald, 16, St. Mary's-road, Bayswater, W.

Date of Election.

Dec. 3, 1896	Trans.	Watson, Wm., Rev., M.A., School House, Kingsbridge, S. Devon
Jan. 29, 1876		Watson, W. H., J.P., Braystones, near Whitehaven
June 21, 1877		Watt, Alexander, c/o Messrs. Macfie and Sons, 34, Moorfields, Liverpool
May 6, 1897		Watts, C. T. F., B.Sc., 7, Cambrian-crescent, Chester
Mar. 1, 1883	Trans.	Watts, Francis, Govt. Laboratory, Kingston, Jamaica
Feb. 1, 1872	Trans.	Watts, John, D.Sc., Merton College, Oxford
Dec. 5, 1878	Trans.	Watts, John I., Fairleigh, Hartford, Cheshire
Dec. 6, 1888		Way, Edward J., F.I.C.,
Mar. 1, 1883	Trans.	Webster, Charles Stuart, Malvern House, Redland, Bristol
Mar. 1, 1866		Webster, G. W., 33, Bridge-street-row, Chester
June 21, 1877		Webster, William,
April 4, 1889		Weir, P. A., Lieut.-Col., M.B., c/o Messrs. King, King and Co., Bombay
Feb. 17, 1898		Weissmüller, E. C., Assistent des Kantons-Chemikers, Bern, Switzerland
Feb. 16, 1888		Welch, J. Cuthbert, Trail, British Columbia
Dec. 7, 1893		Welchman, Frank Ernest, 16, Carlton-road, Putney Hill, S.W.
Feb. 19, 1891		Wellington, Stephen N., M.I.C.E., The Bungalow, The Gas Works, Parel, Bombay
June 19, 1884	Trans.	Wells, James S. C., Ph.D., Hackensack, New Jersey, U.S.A.
Feb. 6, 1890		Wells, S. Russell, B.Sc., M.B., 24, Somerset-street, Portland-place, W.
May 6, 1897		Welsb, John, 12A, Sellar-street, Chester
Feb. 18, 1888	Trans.	Werner, Emil A., 5, Church-avenue, Rathmines, Dublin
Mar. 4, 1886		Wertheimer, Julius, Prof., B.Sc., B.A., F.I.C., Merchant Venturers' Technical College, Bristol
May 6, 1897		West, C. A., Royal College of Science, South Kensington, S.W., and 95, Oakhill-road, East Putney, S.W.
Dec. 6, 1883		Wetzel, Henry A., Messrs. Parke, Davies & Co., Box 470, Detroit, Michigan, U.S.A.
May 5, 1892		Whalley, Lawrence, J. de, 131, Pepys-road, New Cross, S.E.
June 15, 1893		Whalley, Sidney, 29, Norman-road, Canterbury
May 3, 1894		Wheeler, H. L., Ph.D., 1812, Prairie-avenue, Chicago
Feb. 16, 1893		Wheeler, William Ernest,
Dec. 2, 1897		While, A. J., Whinsfield, Barrow-in-Furness
Dec. 3, 1896		Whimster, J. I., 9, Corporation-buildings, Dawsholm, Maryhill, Glasgow
Dec. 3, 1897		Wheelwright, E. W., B.A., Ph.D., The Oaklands, Warley, Oldbury, near Birmingham
April 17, 1879		Whitaker, Thorp, Messrs. Ripley & Sons, Dye Works, Bradford, Yorkshire
Feb. 16, 1893		White, H. C., Prof., Athens, Georgia, U.S.A.
Dec. 3, 1891		White, Henry, 43, Woodstock-road, Sheffield

Date of Election.

Mar. 20, 1862		White, Leedham, 2, Lime-street-square, E. C.
April 4, 1889		White, John Tsawoo, M. A., F. I. C., Treasury Office, Katha, Upper Burmah
May 6, 1897		White, P. T., Horton Field, West Drayton, Middlesex
Dec. 7, 1893		White, William Gilchrist, The Hodge, Broadbottom, near Man- chester
Feb. 5, 1885		Whitehead, Henry H., The Royal Brewery, Brentford
June 18, 1896		Whitehead, James, Roach-place, Rochdale
Dec. 5, 1889		Whitehouse, William, Albany House, Bradmore, Wolverhampton
Dec. 15, 1892		Whiteside, John Lowe, 51, Cannon-street, Bolton
April 15, 1886	Proc.	Whitely, R. Lloyd, 20, Beeches-road, W. Bromwich
Nov. 5, 1863		Whitfield, John, 113, Westborough, Scarborough
June 15, 1893		Whittaker, Thomas, Elwy House, Whalley-road, Accrington
Dec. 5, 1889		Whittam, Matthew, M. A., The Isle of Wight College, Ryde
Dec. 5, 1889		Wigan, Basil P., Rhondda Valley Brewery Co., Treherbert
May 16, 1895		Wigley, H. F. A., Verdin Technical School, Winsford, Cheshire
Dec. 15, 1892		Wigham, F. H., Cherrygarth, Eastmoor-road, Wakefield
Dec. 3, 1896		Wigner, J. H., Ph. D., Eden House, Burrell-square, Crieff, N. B.
Dec. 3, 1896		Wilcox, A. J., St. John's College, Grimsargh, near Preston
May 7, 1891		Wild, John, Park View, Bredbury, Stockport
Mar. 4, 1897	Trans.	Wilderman, Meyer, Ph. D., Davy-Faraday Laboratory, Albemarle- street, W.
June 16, 1881		Wilkes, J. P., 54½, Old Broad-street, E. C.
May 4, 1893		Wilkinson, John, Drighlington, near Bradford
Dec. 17, 1885		Will, Wm. Watson, 1, St. Agnes-place, Kennington Park, S. E.
Feb. 19, 1891		Will, W., Ph. D., Kronprinzen ufer 30, Berlin, N. W.
Jan. 16, 1862	Trans.	Williams, C. Greville, F. R. S., F. I. C., 36, Kenilworth-avenue, Wimbledon
Feb. 21, 1895		Williams, Evan, Gas Works, Rochdale-road, Manchester
Dec. 15, 1892		Williams, John, Government Laboratory, British Guiana
Dec. 5, 1895		Williams, J., B. A., The College, Cheltenham
June 21, 1883	Proc.	Williams, Rowland, Sunny Lea, Aldcliffe-road, Lancaster
June 18, 1891		Williams, Seward W., c/o Seabury and Johnson, 8, Brighton- avenue, East Orange, New Jersey, U. S. A.
Dec. 5, 1872		Williams, Thomas, Chemical Laboratory and Assay Office, A, Queen Insurance-building, 10, Dale-street, Liverpool
Mar. 5, 1885	Trans.	Williams, Walter Collingwood, B. Sc., 68, Grove-street, Liverpool
Feb. 19, 1874	Trans.	Williams, W. Carleton, B. Sc., 23, Broomgrove-road, Sheffield
Dec. 15, 1892		Williams, William, County Offices, Westgate-street, Cardiff, and 63, Plymouth-road, Penarth.
Feb. 7, 1878		Williams, W. J., 2215, Bridge-street, Frankford, Philadelphia, U. S. A.
Feb. 15, 1894		Williams, W. Lloyd, Caxton-road, Miskin-road, Dartford, Kent
May 15, 1848	Trans.	Williamson, A. W., LL. D., F. R. S., High Pitfold, Haslemere

Date of Election.

Dec. 4, 1874	Trans.	Williamson, Robert, c/o Messrs. Williamson and Corder, Walker-on-Tyne
Mar. 4, 1886	Trans.	Williamson, Sidney, Cent. Tech. Coll., S. Kensington
April 21, 1898		Williamson, J. A., 8, Cheverton-road, Upper Holloway, N.
May 7, 1896		Wills, E. Channing, M.A. Cantab., 11, Caledonia-place, Clifton, Bristol
Dec. 5, 1872		Wills, Jos. Lainson, c/o Dr. Wyatt, 29, Stone-street, New York
Dec. 5, 1892	Trans.	Wilsmore, N. Y. M., bei Frau Kühne, Bertheastrasse 3, Göttingen
Feb. 5, 1885		Wilson, A. C., Borough Hall, Stockton-on-Tees
Dec. 6, 1894		Wilson, A. Poole, c/o Commissioners of National Education, Education Office, Marlborough-street, Dublin
June 19, 1879		Wilson, Charles J., 14, Old Queen-street, Westminster
Dec. 6, 1894		Wilson, Christopher, The Grammar School, Manchester
June 21, 1883	Trans.	Wilson, David, jun., Carbeth, Killearn, by Glasgow
Nov. 19, 1855		Wilson, G. F., F.R.S., Heatherbank, Weybridge Heath
Feb. 21, 1895		Wilson, H., 146, High-street, Southampton
April 1, 1875		Wilson, James, M.A., Barrister-at-law, 2, Essex-court, Temple, and 15, Highbury-grange, Highbury, N.
May 16, 1878		Wilson, James Henry, 6, Fenchurch-buildings, E.C.
May 16, 1895		Wilson, John, B.Sc., Battersea Polytechnic, S.W.
Dec. 3, 1891		Wilson, John Henry, A.I.C., 29, Radford-street, Coventry
Nov. 20, 1890		Wilson, J. Mitchell, M.D., Medical Officer of Health, Doncaster
Dec. 6, 1894		Wilson, R. H., Washing Stocks Farm, Bromsgrove
Dec. 7, 1871		Wilson, William John, c/o Paget Prize Plate Co., Watford
Dec. 17, 1885		Wilson, William M., Inland Revenue Laboratory, Burton-on-Trent
Feb. 5, 1874		Wiltshire, Thomas Pemberton, c/o New York Tartar Company, 9th-street and Gowanus Canal, Brooklyn, New York
Dec. 18, 1884		Wilton, Thomas, The Gas Light and Coke Co., Beckton, North Woolwich
Dec. 1, 1887		Winder, Bartlett W., Sunny Bank House, 43, Broomhall-place, Sheffield
Dec. 7, 1893		Winder, Edward Humphreys, Westminster School, S.W.
Feb. 15, 1894		Wingate, Hamilton M., B.Sc., c/o Messrs. J. Wingate and Co., 52, St. Enoch's-square, Glasgow
Dec. 5, 1895		Wingfield, T. R., Nelson-square, Bolton
Mar. 16, 1876		Winser, Percy James, The Acres, Bebington, near Birkenhead
Mar. 2, 1857		Winstone, Benjamin, M.D., 100, Shoe-lane, E.C., and 53, Russell-square, W.C.
Dec. 3, 1891		Winterton, A. W., The Express Steel Co., Port Talbot, South Wales
June 15, 1876	Trans.	Witt, Otto N., Prof., Ph.D., 21, Siegmundshof, Berlin, W.
May 7, 1896		Wolfenden, J. H., B.Sc., 13, Elm-street, Failsworth, Manchester

Date of Election.		
Dec. 5, 1867		Wood, Augustus A., 74, Cheapside, E.C.
April 4, 1889		Wood, Charles, 21, Queen's-road, Bradford, Yorks
Jan. 19, 1860	Trans.	Wood, Charles Henry, 16, Festing-grove, Southsea
Dec. 4, 1890		Wood, Sidney, B.Sc., S. Kensington Museum, S.W.
April 21, 1898	Trans.	Wood, T. B., M.D., Gonville and Caius College, Cambridge
Dec. 18, 1884		Wood, William H., B.A. (Oxon.), La Martinière, Calcutta
Dec. 7, 1871	Trans.	Woodcock, Reginald C., The Sanitation Co., Ltd., 636 to 642, West 55th-street, New York City, U.S.A.
Feb. 18, 1892		Woods, Hugh, 11, Archway-road, Highgate, N.
April 19, 1888		Woodward, James, B.Sc., B.A., F.I.C., 144, Osborne-road, Forest Gate, E.
April 4, 1889		Woolf, Mortimer, 16, Greville-place, N.W.
Dec. 6, 1889		Woosnam, Richard W., 1, The Chase, Wavley Mount, Brentwood, Essex
Dec. 18, 1884		Worrall, J. Hall, F.I.C., Howsley, Chapeltown, near Sheffield
Feb. 4, 1858	Trans.	Worsley, Phillip J., Rodney Lodge, Clifton, Bristol
Dec. 5, 1895		Wright, H. E., 10, Westcott-street, Stockton-on-Tees
Feb. 21, 1878	Trans.	Wright, Lewis Thompson, The Mountain Copper Co., Keswick, California, U.S.A.
June 7, 1894		Wright, Robert, 11, Eagle-parade, Buxton
Mar. 4, 1886	Trans.	Wright, William T., 102, Derbyshire-lane, Sheffield
Feb. 4, 1864		Wrightson, John, Charford House, Salisbury
Feb. 19, 1891		Wyatt, Thomas M., Chemical Department, Royal Arsenal, Woolwich, S.E.
Dec. 2, 1880		Wyborn, John Middleton, 26, Widmore-road, Bromley, Kent
Nov. 20, 1884		Wyley, W. Fitzthomas, Wheatley-street, Coventry
May 7, 1885	Trans.	Wynne, W. Palmer, D.Sc., F.R.S., Royal College of Science South Kensington, S.W.
June 4, 1874		Yates, Robert, 64, Park-street, Southwark
Dec. 16, 1886	Trans.	Yoshida, H., Science College, Imperial University, Tokyo, Japan
Feb. 5, 1885		Young, Alfred C., 64, Tyrwhitt-road, St. John's, S.E.
Mar. 4, 1886		Young, Brougham, 2A, Sigdon-road, Dalston-rise, N.E.
Dec. 2, 1897		Young, F. S., M.A., Mill Hill School, N.W.
Mar. 15, 1877		Young, Frank W., Woodmuir, West Newport, Fife, N.B.
Dec. 4, 1890	Trans.	Young, George, Ph.D., University College, Sheffield
Feb. 21, 1895		Young, H. Stow, Santa Francisca Gold Mines, Leon, Nicaragua, Central America
June 21, 1877		Young, J. Rymer, 42, Sankey-street, Warrington
Feb. 5, 1874		Young, John, 164, Bath-street, Glasgow
June 16, 1887	Trans.	Young, John William, B.Sc., B.A., Analyst's Office, Great Northern Railway Plant, Doncaster, and 25, Hall Gate, Doncaster

Date of Election.

Feb. 16, 1882	Trans.	Young, Sidney, D.Sc., F.R.S., University College, Bristol, and 10, Windsor-terrace, Clifton, Bristol
Dec. 16, 1894		Young, James, 4, Plumstead Common-road, Woolwich
Nov. 6, 1873		Young, W. C., Normanhurst, High-road, Romford, and Chemical Laboratory, 19/20, Aldgate, E.C.
April 4, 1878		Zingler, Maximilian, 19, Buckland-crescent, Belsize Park, N.W., and 16, Fenchurch-street, E.C.

FOREIGN MEMBERS.

NUMBER NOT TO EXCEED FORTY.

Date of Election.	
Jan. 20, 1898	Arrhenius, Prof. S., Bergsgaten 18, Stockholm
May 18, 1876	Baeyer, Adolph von, F.R.S., University of Munich
Feb. 1, 1883	Beilstein, Prof. F., Ph.D., W.O., 8th, No. 17, St. Petersburg
Mar. 1, 1860	Berthelot, M., F.R.S., Collège de France, Paris
Feb. 2, 1888	Boisbaudran, Lecoq de, 113, Rue de Longchamp, Passy, Paris
Feb. 1, 1842	Bunsen, R. W., Ph.D., F.R.S., University of Heidelberg
June 19, 1862	*Cannizzaro, S., Senato di Roma
Feb. 1, 1883	Cleve, Prof. P. T., Ph.D., University, Upsala, Sweden
Jan. 20, 1898	Curtius, Prof. T., Bonn
Feb. 1, 1883	Erlenmeyer, Prof. E., Ph.D., Aschaffenburg
June 16, 1892	Fischer, Emil, Ph.D., University of Berlin
Feb. 1, 1883	Fittig, Prof. R., Ph.D., University, Strassburg
Jan. 20, 1898	Franchimont, Prof. Dr. A. E. N., Leiden
May 18, 1876	Friedel, C., 9, Rue Michelet, Paris
May 3, 1866	Gibbs, Prof. Wolcott, Cambridge, Massachusetts
June 16, 1892	Graebe, Carl, Ph.D., University of Geneva
Feb. 2, 1888	Hoff, Prof. J. H. van't, Ph.D., Uhlandstrasse 2, Charlottenburg
Jan. 20, 1898	Körner, Prof. W., R. Scuola superiore d'agricoltura, Milan
Feb. 2, 1888	Ladenburg, Prof. A., Ph.D., Kaiser Wilhelmstrasse 43, Breslau
Feb. 2, 1888	Landolt, Prof. H., Ph.D., Albrechtstrasse 14, Berlin, N. W.
June 16, 1892	Lieben, Adolph, Ph.D., University of Vienna
Jan. 20, 1898	Markownikoff, Prof. W., Moscow
Feb. 1, 1883	†Mendeléef, Prof. D., Ph.D., University, St. Petersburg
Jan. 20, 1898	Menschutkin, Prof. N., The University, St. Petersburg
Jan. 20, 1898	Moissan, Prof. Henri, 7, Rue Vauquelin, Paris
Feb. 2, 1888	Nilson, Prof. L. F., Ph.D., Albano, Stockholm

* Faraday Lecturer, 1872.

† Faraday Lecturer, 1889.

Date of Election.

Jan. 20, 1898	Ostwald, Prof., Dr. W., Linnéstrasse 2/3, Leipzig
May 3, 1866	Rammelsberg, Prof. C. F., Berlin
Jan. 20, 1898	Raoult, Prof. F. M., Rue des Alpes 2, Grenoble
Jan. 20, 1898	Remsen, Prof. Ira, Johns Hopkins University, Baltimore
June 16, 1892	Schiff, Hugo, Ph.D., University of Florence
June 16, 1892	Schlœsing, Th., Ph.D., Institut Agronomique, Paris
Jan. 20, 1898	Spring, Prof. W., Rue Beckmann 32, Liège
May 18, 1876	Thomsen, Prof. Julius, Ph.D., University of Copenhagen
Jan. 20, 1898	Troost, Prof. L. J., 84, Rue Bonaparte, Paris
Jan. 20, 1898	Waage, Prof. Peter, University, Christiania
Jan. 20, 1898	Waals, Prof. Dr. J. D. van der, T.C., Hooftstraat 117, Amsterdam
Feb. 2, 1888	Wislicenus, Prof. Johannes, Ph.D., University, Leipzig

FARADAY LECTURERS.

1869. J. B. A. Dumas.
 1872. S. Cannizzaro.
 1875. A. W. von Hofmann.
 1879. A. Wurtz.
 1881. H. von Helmholtz.
 1889. D. Mendeléef.
 1895. Lord Rayleigh.

LONGSTAFF MEDALLISTS.

1881. T. E. Thorpe.
 1884. C. O'Sullivan.
 1888. W. H. Perkin.
 1891. F. R. Japp.
 1894. H. T. Brown.
 1897. W. Ramsay.

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LONDON AND BUNGAY.





PROCEEDINGS
OF
THE CHEMICAL SOCIETY.

Vol. XV. Nos. 202—216.
JANUARY—DECEMBER, 1899.

EDITED BY THE SECRETARIES.

LONDON:
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1900.

DATES OF ISSUE OF THE MONTHLY NUMBERS OF THE
JOURNAL OF THE CHEMICAL SOCIETY TO FELLOWS.

January number was issued.....	18th January.
February „	18th February.
March „	17th March.
April „	13th April.
May „	1st May.
June „	1st June.
July „	1st July.
August „	1st August.
September „	1st September.
October „	1st October.
November „	1st November.
December „	1st December.

ERRATA.

Page.	Line.	
24	10	for “methylic- ψ -lanronolate” read “methyl ψ -lauronolate.
55	22	„ “camphor” read “camphene.”
62	11	„ “propene” read “propane.”
68	5	„ “bornylaminic” read “bornylamine.”
71	14	„ “20°” read “21°.”
77	3	omit “E. W.”
239	23	for “acetaldehyde” read “acetic acid.”

LIST OF GRANTS MADE FROM THE RESEARCH FUND DURING THE YEAR.

£5 to W. A. Bone and J. J. Sudborough, to complete a research on the substituted succinic acids.

£10 to W. A. Bone, for an investigation of the cyanosuccinic esters.

£5 to F. S. Young, for an investigation of the products of the oxidation of benzene in presence of ferrous salts.

£20 to J. J. Dobbie, for an investigation of the decomposition products of corydaline.

£15 to A. Lapworth, for an investigation of the constitution of homocamphoronic and camphononic acids, and their relationship to camphoric acid.

£7 to J. A. Gardner, for an investigation of the constitution of camphopyric acid, and of its bromination products.

£20 to W. J. Pope, for an investigation of (a) the mechanism of the conversion of tertiary bases into quaternary ammonium derivatives; (b) the existence of an asymmetric nitrogen atom; and (c) the process of racemation.

£20 to A. W. Crossley and H. R. Le Sueur, to continue their research on the constitution of fatty acids.

£10 to R. S. Morrell and J. M. Crofts, to continue their research on the action of hydrogen peroxide on carbohydrates in the presence of ferrous salts.

£10 to F. W. Dootson, to continue his research on the condensation of methyl acetonedicarboxylate, the constitution of oreinoltricarboxylic acid, and the action of chlorine and bromine on the esters of acetonedicarboxylic acid.

£10 to J. J. Sudborough, to continue his research on the etherification constants of (a) normal fatty acids; (b) substituted acrylic acids; (c) ortho-substituted benzoic acids; and (d) substituted propionic acids, on diortho-substituted benzoic acids, and on the stereochemistry of unsaturated compounds.

£30 to W. J. Pope, to investigate (1) the arrangement in space of the groups attached to triad and pentad nitrogen; (2) to examine sulphonium compounds similarly; (3) to continue work on tetrahydroquinoline and tetrahydro- β -naphthylamine; and (4) to extend the study of enantiomorphism.

£30 to H. E. W. Phillips, for an investigation of the constitution of phosphoric acid solutions by means of the electric conductivity methods of Kohlrausch.

LIST OF FELLOWS ELECTED DURING 1899.

Name.	Proposed.	Elected.
Aders, Robert Henry.....	April 20th	June 15th.
Allworthy, James Herbert	February 2nd.....	May 4th.
Allworthy, Samuel William, M.A.	December 1st, 1898...	February 16th.
Anderson, James William.....	November 2nd.....	December 7th.
Armitage, Francis Paul	" "	" "
Armstrong, Frederick William	" "	" "
Atkinson, George Dekeyne	May 18th	June 15th.
Auchinachie, Peter	February 2nd.....	May 4th.
Baker, Clement Harrison	March 2nd	" "
Beale, Frederick James	" "	" "
Bean, Percy.....	April 20th	June 15th.
Beesley, Frederic Arnold, B.Sc.....	November 2nd.....	December 7th.
Belton, Frank.....	March 16th.....	May 4th.
Bennetts, Benjamin Harvey.....	" "	" "
Blackman, Walter Lionel.....	April 20th	June 15th.
Blackshaw, John Frank	December 1st, 1898...	February 16th.
Blofeld, Stuart, B.A., B.Sc.	December 15th, 1898.	" "
Bolam, Robert Alfred, M.D.	January 15th	" "
Bond, Alfred Ernest.....	March 2nd	May 4th.
Bowles, Bertram H.	December 15th, 1898	February 16th.
Branscombe, William H., B.A.....	November 17th, 1898	" "
Bratby, George Smith	February 16th	May 4th.
Browning, Kendall Colin, B.A.	February 2nd	" "
Carpenter, H. Cort H., B.A., Ph.D.....	December 1st, 1898...	February 16th.
Carpmael, Wilfred	April 20th	June 15th.
Chapman, Edgar Marsh	November 2nd.....	December 7th.
Cheater, Thomas John	December 15th, 1898	February 16th.
Collingridge, William, M.A.	February 2nd	May 4th.
Connah, James, B.Sc.....	May 18th	June 15th.
Connell, Robert D.	March 16th.....	May 4th.
Cope, Frank	December 1st, 1898...	February 16th.
Cozens, Thomas James.....	" "	" "
Danziger, Henry Meldola	May 4th	June 15th.
Darling, Charles Robert	March 2nd	May 4th.
Dewhurst, John Arthur.....	November 2nd.....	December 7th.
Dougall, James Dick	June 1st	" "
Doyle, Frederick	April 20th	June 15th.
Dudderidge, Frank Rawlinson.....	November 2nd.....	December 7th.
Dunscombe, Frederick Charles	April 20th	June 15th.
Eichenauer, William Frederick.....	" "	" "
Eppe, James Washington.....	January 15th	February 16th.
Estcourt, Harry Estcourt	November 17th, 1898	" "
Fairweather, Ernest Barratt.....	January 15th.....	" "
Fermor, H. F. F. Burdett.....	November 2nd.....	December 7th.
Fleischmann, F. N. Ashcroft	April 20th	June 15th.
Fraser, William Gordon	May 4th.....	" "
Fry, George Cecil, B.Sc.	November 17th, 1898	February 16th.
Frye, Colin Charwood.....	January 15th	" "

Name.	Proposed.	Elected.
Gabriel, Edmund Vivian, M.A.	January 15th	February 16th.
Getman, Frederick Hutton	April 20th	June 15th.
Golding, John	November 17th, 1898.	February 16th.
Goltz, Harold Francis Carl	March 16th.....	May 4th.
Gurney, Elliott Henry	November 2nd.....	December 7th.
Haigh, Percy	March 2nd.....	May 4th.
Hall, Samuel Godfrey.....	December 1st, 1898...	February 16th.
Harper, Henry Winston, M.D.....	November 17th, 1898.	" "
Hartley, Harold Brewer, B.A.	January 15th	" "
Hedley, George Ward, M.A.....	December 15th, 1898.	" "
Hemborough, James.....	November 17th, 1898.	" "
Henry, Thomas Anderson.....	December 1st, 1898...	" "
Hübner, Julius.....	April 20th	June 15th.
Hughes, John Elias.....	February 16th	May 4th.
Hunter, Archibald Glen Kidston.....	February 2nd	" "
Johnson, Edward Charles.....	April 20th	June 15th.
Jones, Lauder William, A.B., Ph.D. ...	February 16th	May 4th.
Judge, Thomas, B.A.....	March 2nd.....	" "
Kay, Percy, Ph.D.....	June 15th	December 7th.
Kinnersley, Henry Wulff	November 2nd.....	" "
Knight, Harold Octavius.....	December 15th, 1898.	February 16th.
Lange, Ernest F. Stephen.....	June 1st	December 7th.
Laurie, Dudley Northall	December 15th, 1898.	February 16th.
Leeming, William Thomas, B.Sc.	November 2nd.....	December 7th.
Leon, Arthur Alexander	April 20th	June 15th.
Lett, Stephen Joshua	November 2nd.....	December 7th.
Lewis, Edward Watkin.....	" "	" "
Lindsey, Robert William	March 16th	May 4th.
Linstead, Edward Flatman.....	January 15th	February 16th.
Lucas, Alfred.....	November 17th, 1898	" "
Luxton, Thomas, B.A., B.Sc.	December 1st, 1898...	" "
Mackenzie, Thomas	January 15th	" "
MacLeod, James.....	March 16th	May 4th.
Main, Hugh, B.Sc.....	June 15th.....	December 7th.
Martin, Samuel Montagu.....	November 17th, 1898	February 16th.
Maudsley, Joshua, B.A.	January 15th	" "
McAlley, James.....	April 20th	June 15th.
McClumphy, Robert.....	May 18th	" "
McConnell, William	March 2nd.....	May 4th.
McCracken, James	December 15th, 1898.	February 16th.
McCreath, William D.	November 2nd.....	December 7th.
Mirrlees, Arthur, B.A.	January 15th	February 16th.
Mohr, Bernhard, Ph.D.	" "	" "
Molson, John Cavendish	" "	" "
Morris, Wilfred Walter	March 2nd.....	May 4th.
Nance, John Trengrove, B.A.	January 15th	February 16th.
Neale, Harry Ainley	November 2nd.....	December 7th.
Nicholls, William W. Scott	January 15th	February 16th.
O'Sullivan, John	December 15th, 1898.	" "

Name.	Proposed.	Elected.
Palmer, Thomas Henry	November 2nd.....	December 7th.
Panting, Laurence C., B.A., M.B.	February 2nd	May 4th.
Parkes, George Alfred	April 20th	June 15th.
Peachey, Stanley John	" "	" "
Pearson, Marchant, B.A.	November 2nd.....	December 7th.
Phillips, Eskricke Sidney, B.A.....	May 18th	June 15th.
Pittuck, Frederick Williams	February 16th	May 4th.
Pizey, James Henry.....	November 17th, 1898	February 16th.
Polkinghorne, Bennett C., B.Sc.	November 2nd.....	December 7th.
Ponthieu, Georges.....	" "	" "
Price, Robert Coleman	November 17th, 1898	February 16th.
Pye, Frank J.	" "	December 7th.
Pyne, Horace Seymour.....	January 15th	February 16th.
Raynor, William Downing, B.A.	November 2nd.....	December 7th.
Read, Harold McLean	February 16th	May 4th.
Roberts, James, jun.	December 1st, 1898...	February 16th.
Rossiter, Sidney	April 20th	June 15th.
Roundell, Christopher Foulis, B.A.	November 2nd.....	December 7th.
Royal-Dawson, Henry ...	May 4th	June 15th.
Russell, William	November 2nd.....	December 7th.
Schryver, Samuel Barnet, D.Sc., Ph.D...	February 2nd	May 4th.
Schweich, Maurice Emile	March 2nd	" "
Shelbourn, Edward Thomas	" "	" "
Shelton, Arthur John	February 2nd	" "
Shepherd, William F. John	April 20th	June 15th.
Shepherd, John William, B.Sc.....	May 18th	" "
Simmons, Charles, B.Sc.....	" "	" "
Skirrow, Frederick William, B.Sc ...	December 1st, 1898...	February 16th.
Soddy, Frederick, B.A.....	November 17th, 1898	" "
Stainer, John Ward.....	April 20th	June 15th.
Stansfield, Samuel, B.Sc.....	May 4th	" "
Stevenson, Arnold, B.A.....	January 15th	February 16th.
Szarvasy, Charles Emerique, Ph.D. ...	December 1st, 1898...	" "
Thiersch, Harry Alexander.....	February 16th	May 4th.
Thomson, Robert Tatlock.....	February 2nd	" "
Threlfall, Richard, M.A.	March 2nd	" "
Tyler, Ernest Albert, B.A.	" "	" "
Wade, Arthur Luvian	February 16th	" "
Walden, Allan Frederick, M.A.....	March 16th	" "
Walker, Charles	February 16th	" "
Walter, Louis Heathcote, B.A.	November 17th, 1898	February 16th.
Waltcn, Robert Hawks.....	November 2nd	December 7th.
Watson, Fred Sheasby, B.Sc.....	February 16th	May 4th.
West, George Hardstaff, B.Sc.....	April 20th	June 15th
White, Arthur Lee, B.Sc.....	December 15th, 1898.	February 16th.
White, Henry Fox	January 15th	" "
Whittaker, Christopher Joseph.....	May 4th	June 15th.
Williams, William Arthur.....	November 17th, 1898	February 16th.
Wilson, F. R. Leyland, M.A.....	November 2nd.....	December 7th.
Wilson, John	" "	" "
Wormell, Thomas Wilson, B.Sc.....	December 1st, 1898...	February 16th.

FELLOWS DECEASED.

Name.	Elected.	Died.
Buchanan, Joshua	May 4th, 1893.....	January 13th, 1899.
Bunsen, Robert Wilhelm..	February 1st, 1842	August 16th, 1899.
Dey, Kanny Lall	June 17th, 1880	August 16th, 1899.
Dutta, Ramchandra ...	December 6th, 1883	January 17th, 1899.
Frankland, Sir Edward ...	December 20th, 1847	August 9th, 1899.
Friedel, Charles	May 18th, 1876	April 20th, 1899.
Galton, Sir Douglas	March 4th, 1875	March 10th, 1899.
Harkness, William	December 16th, 1875	September 5th, 1899.
Head, Jeremiah	March 16th, 1876	March 10th, 1899.
Hodges, John F.	April 15th, 1844	December 13th, 1899.
Jackson, Eric H.	December 5th, 1889	July 8th, 1899.
McDougall, Alexander ...	December 17th, 1857 ...	November 13th, 1899.
Newton, Walter.....	March 4th, 1886	August 26th, 1899.
Nilson, L. F.	February 2nd, 1888.....	May 14th, 1899.
Ogston, G. H.	May 4th, 1871.....	July 19th, 1899.
Oxland, Robert	December 15th, 1851	May 11th, 1899.
Plimpton, R. T.	December 2nd, 1880 ..	December 21st, 1899.
Rammelsberg, C. F.	May 3rd, 1866.....	December 29th, 1899.
Reynolds, Henry Charles..	May 17th, 1888	May 1st, 1899.
Richardson, W. H.....	November 17th, 1887.....	July 21st, 1899.
Stanford, Edward C. Cortis	April 21st, 1859	December 8th, 1899.
Sworn, Sidney Augustus..	December 5th, 1889	May 10th, 1899.
Taylor, Andrew	December 2nd, 1875	
Tiemann, Ferdinand J. C. W.	March 17th, 1881	November 14th, 1899.
Watson, David	January 18th, 1872.....	December 15th, 1899.
Williams, W. Lloyd	February 15th, 1894	October 29th, 1899.

TITLES OF PAPERS COMMUNICATED TO THE SOCIETY
DURING 1899.

	Page in Pro- ceedings.	Page in Trans- actions.
<i>January 19th.</i>		
1. Researches on moorland waters. I. Acidity. By William Ackroyd, F.I.C.	1	196
2. Esterification constants of substituted acetic acids. By John J. Sudborough and Lorenzo L. Lloyd	2	467
3. Diortho-substituted benzoic acids. Part IV. Formation of salts from diortho-substituted benzoic acids and different organic bases. By Lorenzo L. Lloyd and John J. Sudborough	3	580
4. α -Ketotetrahydronaphthalene. By F. Stanley Kipping, D.Sc., F.R.S., and Alfred Hill	4	144
5. A new method for preparing unsymmetrical dimethyl- and trimethyl-succinic acids. By William A. Bone.	5	—
6. Production of optically active mono- and di-alkyloxy-succinic acids from malic and tartaric acids. By Thomas Purdie, F.R.S., and William Pitkeathly, B.Sc.	6	153
7. The action of ammonia on ethereal salts of organic acids. By Siegfried Ruhemann	6	245
8. The changes of volume due to dilution of aqueous solutions. By E. B. H. Wade, B.A.	7	254
9. The thermal effects of dilution. By J. Holms Pollok, B.Sc.	8	—
10. Halogen derivatives of acetonedicarboxylic acid. Part I. By Frederick W. Dootson, M.A.	9	169
11. The detection and determination of sucrose in the presence of lactose. By Edwin Dowzard	9	371
12. Note on the interaction of formaldehydewith β -naphthylamine derivatives. By G. T. Morgan, B.Sc.	9	—
<i>February 2nd.</i>		
13. Maltodextrin, its oxidation products and constitution. By Horace T. Brown, LL.D., F.R.S., and J. H. Millar	11	286
14. On attempts to prepare pure starch derivatives through their nitrates. By Horace T. Brown, LL.D., F.R.S., and J. H. Millar	13	308
15. The stable dextrin of starch transformations, and its relation to maltodextrin and to soluble starch. By Horace T. Brown, LL.D., F.R.S., and J. H. Millar.	13	315
16. Propylbenzenesulphonic acids. By Gerald T. Moody, D.Sc.	16	—

	Page in Pro- ceedings.	Page in Trans- actions.
17. The chemistry of the so-called nitrogen iodide.		
Part I. The preparation and properties of nitrogen iodide. By F. D. Chattaway and K. J. P. Orton...	17	—
Part II. The action of reducing agents on nitrogen iodide. By F. D. Chattaway and H. P. Stevens...	17	—
Part III. The composition of nitrogen iodide. By F. D. Chattaway	18	—
Part IV. The action of light on nitrogen iodide. By F. D. Chattaway and K. J. P. Orton	18	—
Part V. The action of alkaline hydrates, of water, and of hydrogen peroxide on nitrogen iodide. By F. D. Chattaway and K. J. P. Orton	18	—
Part VI. The action of acids on nitrogen iodide. By F. D. Chattaway and H. P. Stevens.....	19	—
Part VII. Theory of the formation and reactions of nitrogen iodide. By F. D. Chattaway and K. J. P. Orton.....	20	—
18. An isomeride of amarine. By H. Lloyd Snape, D.Sc., Ph.D., and Arthur Brooke, Ph.D.....	22	208
19. The action of chlorosulphonic acid on paraffins and other hydrocarbons. By Sydney Young, D.Sc., F.R.S.	22	172
20. Derivatives of dibenzylmesitylene. By W. H. Mills and Thomas H. Easterfield.....	22	—
21. On pseudocampholactone and pseudolauronic acid. By Frederick H. Lees and W. H. Perkin, jun.....	23	—
22. Nitrocamphor as an example of dynamic isomerism. By T. Martin Lowry, B.Sc.....	25	211
23. Position-isomerism and optical activity; the methylic and ethylic salts of benzoyl- and of ortho-, meta-, and para-toluylnalic acid. By Percy Frankland, F.R.S., and Frederick Malcolm Wharton.....	25	337
24. Some regularities in the rotatory power of homologous series of optically active compounds. By Percy Frankland, F.R.S.....	26	347
25. On brasilin and hæmatoxilin. By A. W. Gilbody and W. H. Perkin, jun.....	27	—
<i>February 16th.</i>		
26. On the absorption spectrum and constitution attributed to cyanuric acid. By W. N. Hartley, F.R.S.....	46	—
27. A study of the absorption spectra of isatin, carbostyryl, and their alkyl derivatives in relation to tautomerism. By W. N. Hartley, F.R.S., and James J. Dobbie, D.Sc., M.A.....	47	640
28. The estimation of nitrites and nitrates by means of ferrous chloride. By A. Wynter Blyth.....	50	—
29. Estimation of boric acid mainly by physical processes. By A. Wynter Blyth	51	722
30. The interaction of ethylic sodiomalonate and mesityl oxide. A correction. By Arthur W. Crossley.....	52	—

	Page in Pro- ceedings.	Page in Trans- actions.
31. On Lössner's benzoylethyloxysulphocarbamic acid, and the formation of pseudoureas. By Augustus Edward Dixon, M.D.	52	375
32. On certain isomeric tertiary benzylthioureas. By Augustus Edward Dixon, M.D.	54	373
33. Is camphene unsaturated? By J. E. Marsh.	54	—
34. Formation of α -pyrone compounds and their transformation into pyridine derivatives. By Siegfried Ruhemann	55	411
<i>March 2nd.</i>		
35. Bromomethylfurfuraldehyde. By H. J. H. Fenton, M.A., and Mildred Gostling, B.Sc.	57	423
36. The reaction of alkyl iodides with hydroxylamine. Formation of alkylated hydroxylamines and oxanines. By Wyndham R. Dunstan, F.R.S., and Ernest Goulding, B.Sc.	58	792
37. Derivatives of $\alpha\alpha'$ -dibromocamphorsulphonic acid. By Arthur Lapworth	61	553
38. Ethylic $\beta\beta$ -dimethylpropanetetra-carboxylate. By W. Trevor Lawrence.	62	—
39. The action of metallic thiocyanates on certain substituted carbamic and oxamic chlorides; and a new method for the production of thiobiurets. By Augustus Edward Dixon, M.D.	62	388
40. A reaction of some phenolic colouring matters. By A. G. Perkin	65	433
41. Note on the optical activity of gallotannic acid. By Otto Rosenheim, Ph.D., and Philip Schidrowitz, Ph.D.	67	—
<i>March 16th.</i>		
42. The boiling point of liquid hydrogen as determined by a rhodium-platinum resistance thermometer. By James Dewar, LL.D., F.R.S.	70	—
43. Influence of substitution on specific rotation in the bornylamine series. By M. O. Forster, Ph.D., B.Sc.	71	934
44. Contribution to the characterisation of racemic compounds. By A. Ladenburg, For. Mem. C.S.	73	465
45. Rotatory powers of optically active methoxy- and ethoxy-propionic acids prepared from active lactic acid. By Thomas Purdie, F.R.S., and James C. Irvine, B.Sc.	74	483
46. On brasilin and hæmatoxylin. II. By A. W. Gilbody and W. H. Perkin, jun.	75	—
47. Crystallisation of dynamic isomerides. A correction. By T. M. Lowry, B.Sc.	76	—

	Page in Pro- ceedings.	Page in Trans- actions.
<i>April 20th.</i>		
48. The synthesis of some $\beta\beta'$ -dipyridyl derivatives from citrazinic acid. By W. J. Sell, M.A., and H. Jackson, B.A., B.Sc.	98	507
49. Action of hydrogen peroxide on carbohydrates in the presence of iron. By R. S. Morrell, M.A., Ph.D., and J. M. Crofts, B.A., B.Sc.	99	786
50. The condensation of oxalic acid and resorcinol. By John Theodore Hewitt and Arthur Ernest Pitt.	100	518
51. Ethyl ammonium sulphite. By Edward Divers and Masataka Ogawa ...	101	533
52. Ethyl ammonium selenite and non-existence of amido-selenites (selenosamates). By Edward Divers and Seihachi Hada.	101	537
53. The allotropic modifications of phosphorus. By D. L. Chapman, B.A.	102	734
54. On the interaction of mercurous and mercuric nitrites with the nitrites of silver and sodium. By P. C. Rây, D.Sc.	103	—
55. β -Isopropylglutaric acid. By F. H. Howles and Jocelyn F. Thorpe ...	103	—
56. The synthesis and preparation of terebic and terpenylic acids. By W. Trevor Lawrence.	104	527
57. Position-isomerism and optical activity: the comparative rotatory powers of methylic and ethylic ditoluylycerates. By Percy Frankland, F.R.S., and Henry Aston.	105	493
58. Fencholenic acid. By G. B. Cockburn, B.A., B.Sc.	106	501
59. The action of certain acidic oxides upon salts of hydroxy-acids. Part IV. By G. G. Henderson, D.Sc., M.A.; T. W. Orr and R. J. G. Whitehead.	107	542
<i>May 4th.</i>		
60. On the combustion of carbon disulphide. By Harold B. Dixon and E. J. Russell ...	114	600
61. The action of nitric oxide on nitrogen peroxide. By Harold B. Dixon and J. D. Peterkin.	115	613
62. On the mode of burning of carbon. By Harold B. Dixon ...	118	630
63. Crystalline glycollic aldehyde. By Henry J. Horstman Fenton and Henry Jackson ...	119	575
64. On the blue salt of Fehling's solution and other cuprotartrates. By Orme Masson and B. D. Steele.	120	725
65. The preparation of acid phenolic salts of dibasic acids. By S. B. Schryver, D.Sc., Ph.D.	121	661
66. The maximum pressure of naphthalene vapour. By R. W. Allen, M.A.	122	—
67. Scoparin. By Arthur George Perkin.	123	—
68. On a new compound of arsenic and tellurium. By E. C. Szarvasy, Ph.D., and C. Messinger, Ph.D.	123	597

	Page in Pro- ceedings.	Page in Trans- actions.
69. The action of hydrogen peroxide on secondary and tertiary aliphatic amines. Formation of alkylated hydroxylamines and oxamines. By Wyndham R. Dunstan and Ernest Goulding	124	1004
70. The enantiomorphously related tetrahydroquinaldines. By William Jackson Pope and Stanley John Peachey	124	—
<i>May 18th.</i>		
71. Corydaline. Part VI. By James J. Dobbie and Alexander Lauder	129	670
72. Oxidation of furfural by hydrogen peroxide. By C. F. Cross, E. J. Bevan, and T. Heiberg	130	747
73. Note on the reactions between sulphuric acid and the elements. By R. H. Adie	132	—
74. On the action of ethylene dibromide and of trimethylene dibromide on the sodium derivative of ethylic cyanacetate. By H. C. Harold Carpenter and William H. Perkin, jun.	133	921
75. The maximum vapour pressure of camphor. By R. W. Allen, M.A.	135	—
<i>June 1st.</i>		
76. The hydrosulphides, sulphides, and polysulphides of potassium and sodium. By W. Popplewell Bloxam.	146	—
77. On the relative efficiency of various forms of still-head for fractional distillation. By Sydney Young, D.Sc., F.R.S.	147	679
78. The salts of dimethylpyrone and the quadrivalence of oxygen. By J. N. Collie, Ph.D., F.R.S., and Thomas Tickle	148	710
79. The symmetrical di-isopropylsuccinic acids. By William A. Bone and C. H. G. Sprankling	149	—
80. Active and inactive phenylalkyloxyacetic acids. By Alex. McKenzie, M.A., D.Sc.	149	753
81. The chemical composition of the oleo-resin of <i>Dacryodes hexandra</i> . By A. More	150	718
82. The condensation of ethyl acetonedicarboxylate: the constitution of triethyl orcintricarboxylate. By David Smiles Jerdan.	151	808
83. A series of substituted nitrogen chlorides. By F. D. Chattaway and K. J. P. Orton	152	1046
<i>June 15th.</i>		
84. On the decomposition of chlorates, with special reference to the evolution of chlorine and oxygen. By W. H. Sodeau, B.Sc.	157	137*

	Page in Pro- ceedings.	Page in Trans- actions.
85. Action of hydrogen peroxide on formaldehyde. By A. Harden, M.Sc., Ph.D.....	158	—
86. Homocamphoric and camphonic acids. By Arthur Lapworth and Edgar M. Chapman.....	159	980
87. Action of silver compounds on α -dibromocamphor. By Arthur Lapworth	161	—
88. The colouring matter of cotton flowers. By A. G. Perkin	161	825
89. Experiments on the synthesis of camphoric acid. By H. A. Auden, W. H. Perkin, jun., and J. L. Rose...	162	909
90. Methylisoamylsuccinic acid. I. By W. Trevor Lawrence.....	163	—
91. Condensations of anhydrazetonebenzil and its analogues with aldehydes. By Francis R. Japp, F.R.S., and Alexander Findlay, M.A., B.Sc.....	164	1017
92. Triphenyloxazolone. By Francis R. Japp, F.R.S., and Alexander Findlay, M.A., B.Sc.....	165	1027
93. Interaction of phenanthraquinone, acetophenone, and ammonia. By Francis R. Japp, F.R.S., and Andrew N. Meldrum, B.Sc.	166	1032
94. Furfuran derivatives from benzoin and phenols. By Francis R. Japp, F.R.S., and Andrew N. Meldrum, B.Sc.....	167	1035
95. Interaction of benzoin with phenylenediamines. By Francis R. Japp, F.R.S., and Andrew N. Meldrum, B.Sc.	169	1043
96. The condensation of ethyl salts of acids of the acetylene series with ketonic compounds. By Siegfried Ruhe- mann and A. V. Cunningham	169	778
97. Dextro-ac-tetrahydro- β -naphthylamine. By William Jackson Pope	170	—
98. The resolution of racemic tetrahydroparatoluquinaldine into its optically active components. By William Jackson Pope and Edmund Milton Rich ..	171	—
99. Isomeric salts of hydrindamine containing pentavalent nitrogen. By Frederic Stanley Kipping, D.Sc., F.R.S.	172	—
100. Synthesis of phenoketoheptamethylene. By F. Stanley Kipping, D.Sc., F.R.S., and Miss L. Hall...	173	—
101. Organic compounds containing silicon. By F. Stanley Kipping, D.Sc., F.R.S., and Lorenzo L. Lloyd	174	—
102. The velocity of reaction before complete equilibrium. By Meyer Wilderman, B.Sc., Ph.D.	175	—
103. The ultra-violet absorption spectra of albuminoids in relation to that of tyrosin. By A. Wynter Blyth ...	175	—
104. An explanation of the laws which govern substitution in the case of benzenoid compounds. (Third Notice.) By Henry E. Armstrong	176	—
105. The colouring matters of dyer's broom and heather. By A. G. Perkin and F. G. Newbury.....	179	830

	Page in Pro- ceedings.	Page in Trans- actions.
<i>Papers received during vacation and published in Trans- actions.</i>		
106. Researches on the alkyl-substituted succinic acids. Part I. Methods of preparation. By William A. Bone and Charles H. G. Sprankling	131	839
107. Some derivatives of dibenzyl ketone. By Francis E. Francis, B.Sc., Ph.D.....	181	865
108. Action of light and of oxygen on dibenzyl ketone. By Emily C. Fortey, B.Sc.	182	871
109. The vapour pressures, specific volumes, and critical constants of hexamethylene. By Sydney Young, D.Sc., F.R.S., and Emily C. Fortey, B.Sc.	182	873
110. The composition and tensions of dissociation of the ammoniacal chlorides of cadmium. By Wm. R. Lang, D.Sc., and Albert Rigant	182	883
111. The aluminium-mercury couple. I. Action of sulphur chloride on some hydrocarbons in presence of the couple. By Julius B. Cohen and Frederick W. Skirrow	183	887
112. The aluminum-mercury couple. II. The action of bromine on organic compounds in presence of the couple. By Julius B. Cohen and Henry D. Dakin...	183	893
113. Experiments on the constitution of isocamphoric acid. By W. H. Perkin, jun., and Jocelyn Field Thorpe.....	184	897
114. The <i>cis</i> - and <i>trans</i> - β -phenylbutane- $\alpha\alpha$, $\alpha\gamma$ -tricarboxylic acids. By Jocelyn Field Thorpe and William Udall	184	904
115. Further studies on the acids of the acetylene series. By Siegfried Ruhemann and Alfred V. Cunningham	185	954
116. A contribution to the chemistry of the mandelic acids. By Alex. McKenzie, M.A., D.Sc.....	186	964
117. Non-existence of the so-called "suboxide of phosphorus." By David Leonard Chapman and F. Austin Lidbury	186	973
118. The chlorine derivatives of pyridine. Part III. The interaction of chlorine and pyridine hydrochloride. By W. J. Sell, M.A., F.I.C., and F. W. Dootson, M.A.	187	979
119. Amidoamidines of the naphthalene series. By Raphael Meldola and Percy P. Phillips	187	1011
<i>November 2nd.</i>		
120. On methods for determining the relative proportions of gaseous chloroform and air in a mixture of the two, and on a method for producing a mixture of air and chloroform in any desired proportion. By A. Vernon Harcourt	188	1060
121. The theory of saponification. By J. Lewkowitsch ...	190	—
122. Note on the action of dilute nitric acid upon oleic and elaidic acids. By F. G. Edmed, B.Sc.	190	—

	Page in Pro- ceedings.	Page in Trans- actions.
123. Formation of tetrazoline. By S. Ruhemann and H. E. Stapleton	191	—
124. Asymmetric optically active nitrogen compounds. Dextro- and lævo-benzylphenylallylmethylammonium iodides and bromides. By William Jackson Pope and Stanley John Peachey	192	—
125. Camphoroxime. Part III. Behaviour of camphoroxime towards potassium hypobromite. By M. O. Forster, Ph.D., D.Sc.	193	—
126. Optical influence of an unsaturated linkage on certain derivatives of bornylamine. By M. O. Forster	194	—
127. The interaction of sodium hydroxide and benzaldehyde. By Charles A. Kohn, B.Sc., Ph.D., and W. Trantom, B.Sc., Ph.D.	194	—
128. Electrolytic preparation of induline dyes: By E. C. Szarvasy, Ph.D.	194	207*
129. The heat of combination of copper with zinc. By T. J. Baker, B.Sc.	195	—
130. The action of sulphuric acid on fenchone. By J. E. Marsh	196	1058
131. On glucosides. By Hugh Ryan, M.A.	196	1054
132. Notes on polyazo-compounds. By Raphael Meldola and William Arthur Williams	196	—
133. On ethyl dibromobutanetetra-carboxylate and the synthesis of tetrahydrofurfuran- $\alpha\alpha'$ -dicarboxylic acid. By Bevan Lean, D.Sc., B.A.	197	103*
134. The application of powerful optically active acids to the resolution of externally compensated basic substances. Resolution of tetrahydroquinaldine. By William Jackson Pope and Stanley John Peachey ...	199	1066
135. The application of powerful optically active acids to the resolution of feebly basic substances. Resolution of camphoroxime. By William Jackson Pope	199	1105
136. The application of powerful optically active acids to the resolution of externally compensated basic substances. Resolution of tetrahydroparatoluquin-aldine. By William Jackson Pope and Edmund Milton Rich	200	1093
137. Homogeneity of dextrolævo- α -phenethylamine dextro-camphorsulphonate. By William Jackson Pope and Alfred William Harvey	200	1110
138. The characterisation of racemic liquids. By Frederic Stanley Kipping and William Jackson Pope	200	1111
139. A method for discriminating between 'non-racemic' and 'racemic' liquids. By William Jackson Pope and Stanley John Peachey	201	119*
140. On two hydrated cobalt oxides, green- and buff-coloured. By W. N. Hartley, F.R.S.	202	—
141. A method of separating isomeric xylenes from the commercial product. By W. R. Hodgkinson and L. Limpach	202	—
142. Action of hydrolytic agents on α -dibromocamphor, and the constitution of bromocamphoreuic acid. By Arthur Lapworth	202	—

	Page in Pro- ceedings.	Page in Trans- actions.
<i>November 16th.</i>		
143. The chlorine derivatives of pyridine. Part IV. The constitution of the tetrachloropyridines. By W. J. Sell, M.A., F.I.C., and F. W. Dootson, M.A.	205	1*
144. Contributions to our knowledge of the aconite alkaloids. Part XV. On japaconite and the alkaloids of Japanese aconite. By Wyndham R. Dunstan, F.R.S., and Harold M. Read	206	45*
145. The dissociation constants of very weak acids. By James Walker and William Cormack	208	5*
146. Preparation and properties of solid ammonium cyanate. By James Walker and John K. Wood ..	209	21*
147. Etherification of derivatives of β -naphthol. By William A. Davis	210	33*
148. On the determination of transition temperatures. By H. M. Dawson, Ph.D., B.Sc., and P. Williams, B.Sc.	210	—
149. Constitution of amarine, of its supposed dialkyl- and diacyl-derivatives, and of isoamarine. By Francis R. Japp, F.R.S., and James Moir, M.A., B.Sc.	211	—
150. The atomic weight of nitrogen. By G. Dean, B.A. ...	213	117*
<i>December 7th.</i>		
151. The oxidation of certain organic acids in presence of ferrous salts. By Henry J. Horstman Fenton, M.A., F.R.S., and H. O. Jones, B.A., B.Sc.	224	69*
152. Oxalacetic acid. By Henry J. Horstman Fenton, M.A., F.R.S., and H. O. Jones, B.A., B.Sc.	224	77*
153. Determination of the constitution of fatty acids. Part II. By Arthur William Crossley and Henry Rondel Le Sueur	225	83*
154. The reaction between sulphuric acid and potassium ferrocyanide. By R. H. Adie, M.A., B.Sc., and K. C. Browning, B.A.	226	150*
155. The sulphates of bismuth. By R. H. Adie, M.A., B.Sc.	226	—
156. On sulphates of the form $R_2SO_4 \cdot 2MSO_4$; especially those of isometric crystallisation. By F. R. Mallet. .	227	216*
157. Reactions of the so-called dibenzylamarine. By Francis R. Japp, F.R.S., and James Moir, M.A., B.Sc.	227	—
158. Note on isoamarine. By H. Lloyd Snape, D.Sc., Ph.D.	228	—
159. On the preparation of benzene azo-orthonitrophenol. By J. T. Hewitt, M.A., D.Sc.	229	99*
160. Some new osazones and tetrazones. By Harold A. Auden	229	—
161. A series of substituted nitrogen chlorides. Part II. The trichloro-phenyl-acyl-nitrogen chlorides. By F. D. Chattaway and K. J. P. Orton	232	134*

	Page in Pro- ceedings.	Page in Trans- actions.
162. The reaction between cupric sulphate solution and magnesium, zinc, and iron. By R. M. Caven. B.Sc., F.I.C.	232	—
<i>December 21st.</i>		
163. On the refractive and magnetic rotatory powers of some aromatic hydrocarbons, and on the refractive powers of mixtures. By W. H. Perkin, LL D., F.R.S	237	267*
164. Formation of α - and β -acrose from glycollic aldehyde. By Henry Jackson, B.A.	238	129*
165. The interaction of mercurous nitrite and ethyl iodide. By P. C. Rây, D.Sc.	239	—
166. On mercurous iodide. By P. C. Rây, D.Sc.	239	—
167. The action of alkyl iodides on the mercuric iodide sulphides of the fatty series. By Samuel Smiles, B.Sc.	240	160*
168. On brasilin and hæmatoxylin. Part III. By A. W. Gilbody and W. H. Perkin, jun.	241	—
169. The action of alcoholic potash on monobromoglutaric ester. By N. E. Bowtell and W. H. Perkin, jun. ...	241	—
170. Luteolin. III. By A. G. Perkin.	242	—
171. The action of chloroform and potassium hydroxide on orthoamidobenzoic acid. By Walter J. Elliott, M.A	243	213*
172. Azo- and hydrazone compounds differentiated by bromine. By H. E. Armstrong.	243	—

* Papers printed in the Transactions for 1900 are distinguished by an asterisk after the page number. Where no reference is given to the Transactions, the paper has appeared only in the "Proceedings."

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INDEX TO AUTHORS' NAMES.

- Ackroyd, William, 1.
 Adie, R. H., 132, 226.
 Allen, R. W., 122, 135.
 Armstrong, H. E., 176, 243.
 Aston, Henry, 105.
 Auden, H. A., 162, 229.
 Baker, T. J., 195.
 Bevan, E. J., 130.
 Bloxam, W. P., 146.
 Blyth, A. Wynter, 50, 51, 175.
 Bone, W. A., 5, 149, 181.
 Bowtell, N. E., 241.
 Brooke, Arthur, 22.
 Brown, H. T., 11, 13.
 Browning, K. C., 226.
 Carpenter, H. C. H., 133.
 Caven, R. M., 232.
 Chapman, D. L., 102, 186.
 Chapman, E. M., 159.
 Chattaway, F. D., 17, 18, 19, 20, 152, 232.
 Cockburn, G. B., 106.
 Cohen, J. B., 183.
 Collie, J. N., 148.
 Cormack, William, 203.
 Crofts, J. M., 99.
 Cross, C. F., 130.
 Crossley, A. W., 52, 225.
 Cunningham, A. V., 169, 185.
 Dakin, H. D., 183.
 Davis, W. A., 210.
 Dawson, H. M., 210.
 Dean, G., 213.
 Dewar, James, 70.
 Divers, Edward, 101.
 Dixon, A. E., 52, 54, 62.
 Dixon, H. B., 114, 115.
 Dobbie, J. J., 47, 129.
 Dootson, F. W., 9, 187, 205.
 Dowzard, Edwin, 9.
 Dunstan, W. R., 58, 124, 206.
 Easterfield, T. H., 22.
 Edmed, F. G., 190.
 Elliott, W. J., 243.
 Fenton, H. J. H., 57, 119, 224.
 Findlay, Alexander, 164, 165.
 Forster, M. O., 71, 193, 194.
 Fortey, E. C., 182.
 Francis, F. E., 181.
 Frankland, Percy, 25, 26, 105.
 Gilbody, A. W., 27, 75, 241.
 Gostling, Mildred, 57.
 Goulding, Ernest, 58, 124.
 Hada, Seihachi, 101.
 Hall, L., 173.
 Harcourt, A. Vernon, 188.
 Harden, Arthur, 158.
 Hartley, W. N., 46, 47, 202.
 Harvey, A. W., 200.
 Heiberg, T., 130.
 Henderson, G. G., 107.
 Hewitt, J. T., 100, 229.
 Hill, Alfred, 4.
 Hodgkinson, W. R., 202.
 Howles, F. H., 103.
 Irvine, J. C., 74.
 Jackson, Henry, 98, 119, 238.
 Japp, F. R., 164, 165, 166, 167, 169, 211, 227.
 Jerdan, D. S., 151.
 Jones, H. O., 224.
 Kipping, F. Stanley, 4, 172, 173, 174, 200.
 Kohn, C. A., 194.
 Ladenburg, A., 73.
 Lang, W. R., 182.
 Lapworth, Arthur, 61, 159, 161, 202.
 Lauder, Alexander, 129.
 Lawrence, W. T., 62, 104, 163.
 Lean, Bevan, 197.
 Lees, F. H., 23.
 Le Sueur, H. R., 215.
 Lewkowitsch, J., 190.
 Lidbury, F. A., 186.
 Limpach, L., 202.
 Lloyd, L. L., 2, 3, 174.
 Lowry, T. M., 25, 76.
 Mallet, F. R., 227.
 Marsh, J. E., 54, 196.
 Masson, Orme, 120.
 McKenzie, Alex., 149, 186.
 Meldola, Raphael, 187, 196.
 Meldrum, A. N., 166, 167, 169.
 Messenger, C., 123.
 Millar, J. H., 11, 13.
 Mills, W. H., 22.
 Moir, James, 211, 227.
 Moody, G. T., 16.
 More, A., 150.
 Morgan, G. T., 9.
 Morrell, R. S., 99.
 Newbury, F. G., 179.
 Ogawa, Masataka, 101.
 Orr, T. W., 107.
 Orton, K. J. P., 17, 18, 20, 152, 232.

- Peachey, S. J., 124, 192, 199, 201.
 Perkin, A. G., 65, 123, 161, 179, 242.
 Perkin, W. H., 237.
 Perkin, W. H., junr., 23, 27, 75, 133, 162, 184, 241.
 Peterkin, J. D., 115.
 Phillips, P. P., 187.
 Pitkeathly, William, 6.
 Pitt, A. E., 100.
 Pollock, J. Holms, 8.
 Pope, W. J., 124, 170, 171, 192, 199, 200, 201.
 Purdie, Thomas, 6, 74.
 Ray, P. C., 103, 239.
 Read, H. M., 206.
 Rich, E. M., 171, 200.
 Rigaut, Albert, 182.
 Rose, J. L., 162.
 Rosenheim, Otto, 67.
 Ruhemann, Siegfried, 6, 55, 185, 191.
 Russell, E. J., 114.
 Ryan, Hugh, 196.
 Schidrowitz, Philip, 67.
 Schryver, S. B., 121.
 Sell, W. J., 98, 187, 205.
 Skirrow, F. W., 183.
 Smiles, Samuel, 240.
 Snape, H. Lloyd, 22, 228.
 Sodeau, W. H., 157.
 Sprankling, C. H. G., 149, 181.
 Stapleton, H. E., 191.
 Steele, B. D., 120.
 Stevens, H. P., 17, 19.
 Sudborough, J. J., 2, 3.
 Szarvasy, E. C. 123, 194.
 Thorpe, J. F., 103, 184.
 Tickle, Thomas, 148.
 Trantom, W., 194.
 Udall, William, 184.
 Wade, E. B. H., 7.
 Walker, James, 208, 209.
 Wharton, F. M., 25.
 Whitehead, R. J. G. 107.
 Wilderman, Meyer, 175.
 Williams, P., 210.
 Williams, W. A., 196.
 Wood, J. K., 209.
 Young, Sydney, 22, 147, 182.

INDEX TO DISCUSSIONS.

- Armstrong, H. E., 14, 21, 72, 192.
 Blount, Bertram, 190.
 Blyth, A. Wynter, 50, 51.
 Briggs, J. F., 15.
 Brown, H. T., 16.
 Chapman, A. C., 51.
 Chattaway, F. D., 21.
 Clowes, Frank, 119.
 Coste, J. H., 50.
 Cross, C. F., 15, 132, 159.
 Crossley, A. W., 72.
 Debus, H., 159.
 Dewar, James, 2, 21, 49, 116.
 Dobbie, J. J., 49.
 Dunstan, W. R., 208.
 Edmed, F. G., 191.
 Fenton, H. J. H., 15, 100, 132, 239.
 Forster, M. O., 61, 73.
 Gladstone, J. H., 48, 238.
 Groves, C. E., 117.
 Harcourt, A. Vernon, 190, 208.
 Harden, Arthur, 49.
 Hartley, W. N., 49.
 Hehuer, Otto, 190.
 Hewitt, J. T., 60.
 Howard, David, 207.
 Jones, L. M., 208.
 Lapworth, Arthur, 122.
 Lewkowitsch, J., 72, 74, 190, 191, 193.
 Ling, A. R., 15.
 Morris, G. Harris, 15.
 Perkin, W. H., 190, 238.
 Pope, W. J., 73.
 Ramsay, William, 116.
 Scott, A., 21.
 Smithells, Arthur, 115.
 Stapleton, H. E., 191.
 Thorne, L. T., 120.
 Thorpe, T. E., 238.
 Tilden, W. A., 115, 117, 207, 209.
 Walker, James, 209.
 Wynne, W. P., 115.
 Young, F. S., 131.
 Young, George, 191.

INDEX OF SUBJECTS.

- Absorption spectra of albuminoids, 175.
 Absorption spectrum of cyanuric acid, 47;
 isatin, 47; carbostyryl, 47; tyrosin,
 175; electrodes for producing, 49.
 Acetic acids, esterification constants of
 substituted, 2.
 Acetochloro-galactose, preparation and
 properties of, 196.
 Acetonedicarboxylic acid, halogen de-
 rivatives of, 9.
 Acetylaminophenanthrone, preparation
 and properties of, 166.
 Acetophenonephenanthraquinone, pre-
 paration and properties of, 167.
 Acetylalazarin, preparation and proper-
 ties of, 66.
 Acetyldehydrotetramethylhæmatoxyl-
 one, preparation and properties of, 28.
 Acetylpropionylsalicylic acid osazone,
 preparation and properties of, 231.
 Acetylene series, acids of the, 185.
 Acidity of moorland waters, 1.
 Acids, dissociation constants of weak,
 208; oxidation of organic, in presence
 of iron, 224; constitution of fatty, 225.
 Aconite, Japanese, alkaloids of, 206.
 Aeroses from glycollic aldehyde, forma-
 tion of, 239.
 Albuminoids, absorption spectra of, 175.
 Alkylsubstituted succinic acids, pre-
 paration of, 181.
 Allotropic phosphorus, 102.
 Aluminium-mercury couple, 183.
 Amarine, constitution of, 211.
 — an isomeride of, 22.
 Amidoamines of the naphthalene series,
 187.
o-Amidobenzoic acid, derivatives of, 243.
 Amidoselenites, non-existence of, 101.
 Ammonia, action of, on ethereal organic
 salts, 6.
 Ammonium cyanate, preparation and
 properties of solid, 209.
 Anhydrazetonebenzil, condensation of,
 with aldehydes, 164.
 Anhydrohomocamphoronic acid, prepara-
 tion and properties of, 160.
ab-Anisoilbenzylthiocarbamide, prepara-
 tion and properties of, 54.
ab-Anisoilmethylthiocarbamide, prepara-
 tion and properties of, 53.
n-Anisoil- γ -phenylbenzylthiourea, pre-
 paration and properties of, 54.
ab-Anisoilphenylthiocarbamide, prepara-
 tion and properties of, 53.
 Anisoilthiocarbimide, preparation and
 properties of, 53.
 Anisoilthiohydantoin, preparation and
 properties of, 53.
 Anisoilthiourea, preparation and proper-
 ties of, 53.
 Anisoilthiourethane, preparation and pro-
 perties of, 53.
 Aromatic hydrocarbons, refractive and
 magnetic rotatory powers of certain,
 237.
 Arsenic, a new telluride of, 123.
 "Associated" molecules and rotatory
 power, 26.
 Asymmetric nitrogen, 192.
 Atomic weight of nitrogen, 213.
 Auditors, appointment of, 46.
 Benzaldehyde, formation of benzyl alcohol
 from, 194.
 Benzeneazo-*o*-nitrophenol, preparation
 of, 229.
 Benzimidobenzhydrylic oxide, prepara-
 tion and properties of, 166.
 Benzimidoxydiphenylacetic acid, pre-
 paration and properties of, 165.
 Benzohexaphenyltrifurfuran, preparation
 and properties of, 168.
 Benzoic acids, salts of di-*o*-substituted,
 with different organic bases, 3.
m- and *p*-Benzotetraphenyldifurfuran,
 preparation and properties of, 168.
m-Benzotetraphenyldipyrrole, prepara-
 tion and properties of, 169.

- Benzoylbenzyl-*i*-diphenylethylenediamine, preparation and properties of, 228.
- Benzoyl-*s*-dibenzyl-*i*-diphenylethylenediamine, preparation and properties of, 211.
- Benzoylethoxysulphocarbamic acid, of Lössner, 52.
- ab*-Benzoylmethylurea, preparation and properties of, 53.
- Benzoyl-*l*-tetrahydroquinaldine, preparation and properties of, 125.
- Benzoyl-*d*-tetrahydroquinaldine, preparation and properties of, 126.
- Benzoyltetrahydro-*p*-toluquinaldine, preparation and properties of, 171.
- Benzoyl-*l*-tetrahydro-*p*-toluquinaldine, preparation and properties of, 171.
- Benzyl α -diphenyl- β -thioallophanate, preparation and properties of, 64.
- Benzylidene- α -anhydrobenzylævulinic acid, preparation and properties of, 165.
- Benzylidene bornylamine, 194.
- Benzylidene diphenylcyclopentenone, preparation of, 165.
- n*-Benzyl-*v*-methylbenzylthiourea, preparation and properties of, 54.
- d*- and *l*-Benzylphenylallylmethylammonium *d*-camphorsulphonate, their preparation and properties, 192.
- Benzylphenylcarbamyliothiocyanate and its derivatives, preparation and properties of, 64.
- α -Benzylphenyl-*c*-diphenylthiobiuret, preparation and properties of, 63.
- Bidesyl-*p*-phenylenediamine, preparation and properties of, 169.
- Bismuth, sulphates of, 226.
- Bornylamine bases prepared, 72.
- derivatives, preparation and properties of, 194.
- Boric acid, estimation of, 51.
- Brazilin, constitution of, 75.
- Bromine as differentiating azo- and hydrazone compounds, 243.
- action of, on glucosone, 100.
- — — in presence of aluminium-mercury couple, 184.
- Bromination, effect of light on, 21.
- Bromocamphorenic acid, constitution of, 161, 202.
- Bromocamphorsulphopiperidine, preparation of, 61.
- Bromomethylfurfuraldehyde, preparation and properties of, 57.
- Broom (*Spartium scoparium*), colouring matter of, 123.
- Cadmium ammoniacal chlorides of, 182.
- Calluna vulgaris*, colouring matter of, 179.
- Camphene, the saturation of, 55.
- dibromide, preparation and properties of, 55.
- Camphononic acid, preparation and properties of, 160.
- bromophenylhydrazone, preparation and properties of, 160.
- semicarbazone, 160.
- Camphor, maximum vapour pressure of, 135.
- Camphoric acid, constitution of, 162.
- Camphoroxime, resolution of, 199.
- interaction with potassium hypobromite, 193.
- Candidates for election, certificates of, 31, 87, 97, 136, 214.
- Carbohydrates, reaction of, with hydrogen peroxide, 99.
- Carbon, mode of burning of, 118.
- disulphide, combustion of, 114.
- Carbostyryl group, spectra of, 47.
- β -Carvacrol-glucoside, preparation and properties of, 196.
- Chlorates, decomposition of, 157.
- Chlorine from decomposition of chlorates, 158.
- Chloroform, estimation of, mixed with air, 188.
- Chlorosulphonic acid, action of, on isoparaffins, &c., 12.
- p*-Chlorophenylacetylnitrogen chloride, preparation and properties of, 153.
- p*-Chlorophenylformylnitrogen chloride, preparation and properties of, 153.
- Cinnamylideneanhydrazetonebenzil, preparation and properties of, 164.
- Citrazinic acid, $\beta\beta$ -dipyridyl derivatives of, 98.
- Claus and Elb's dibenzylamarine, 211, 227.
- Cobalt, two hydrated oxides of, 202.
- Colouring matters of broom, 123; cotton flowers, 161; Dyer's broom, 179; heather, 179.
- — — reaction with alkaline acetates of phenolic, 65.
- Corydaldine, preparation and properties of, 129.
- Cotton flowers, colouring matter of, 161.
- Concill, proposed changes in, read at February meeting, 46.
- β -*o*- and *p*-Cresol-glucoside, preparation and properties of, 196.
- Cumylideneanhydrazetonebenzil, preparation and properties of, 164.
- Cupric sulphate solution, reaction with magnesium, zinc, and iron, 232.
- Cuprotartrates, preparation and properties of, 120.
- Cyanuric acid, absorption spectrum and constitution of, 46.

- Cymodiphenylfurfuran, preparation and properties of, 168.
- Dacryodes hexandra*, composition of the oleo-resin of, 150.
- Dalton, presentation of memorials of, to the Society, 69.
- Dehydrotrimethylbrazilone, preparation and properties of, 27.
- Desylthymol, preparation and properties of, 168.
- Dextrin, the stable, of starch transformations, preparation and properties of, 13.
- Dextrinic acid, preparation and properties of, 14.
- Diastase, action of, on stable dextrin, 14.
- Diazosalicic acid, preparation and properties of, 231.
- Dibenzoylmesitylenic acid, preparation and properties of, 23.
- Dibenzoyltrimesic acid, preparation and properties of, 23.
- Dibenzoylulvic acids, preparation and properties of, 23.
- "Dibenzylamarine," 211.
- reactions of so-called, 227.
- Dibenzylamaronium salts, preparation and properties of, 228.
- Dibenzylketone, derivatives of, 181.
- action of light and oxygen on, 182.
- Dibenzylmesitylene, preparation and properties of, 23.
- Dibenzyl- β -naphthylamine, preparation and properties of, 10.
- α -Dibromocamphor, action of hydrolytic agents on, 202.
- action of silver compounds on, 161.
- $\alpha\alpha'$ -Dibromocamphorsulphonic acid, salts of, 61.
- $\alpha\alpha'$ -Dibromocamphorsulphopiperidide, preparation of, 61.
- 2:4-Dichlorobenzoylnitrogen chloride, preparation and properties of, 153.
- 2:4-Dichlorophenylacetylnitrogen chloride, preparation and properties of, 153.
- 2:4-Dichlorophenylformyl nitrogen chloride, preparation and properties of, 153.
- Diethylhydroxylamine hydriodide, preparation and properties of, 59.
- Diethylhydroxylamines, preparation and properties of, 59, 124.
- Diethyl orcintricarboxylate, preparation and properties of, 151.
- Dihydrotetrazine, 191.
- Dihydroxyacetophenonemonomethyl ether, preparation and properties of, 123.
- Dihydroxybutanetetracarboxylic acid, preparation and properties of, 198.
- Dimethylbutanetricarboxylic acid, preparation and properties of, 184.
- Dimethylpyrone, preparation and properties of the salts of, 148.
- Diphenylacetyldiaminodihydrophenanthrene, preparation and properties of, 166.
- Diphenylcarbamyliothiocyanate, preparation of, 63.
- α -Diphenylcarbamyli- β -phenylthiosemicarbazide, preparation and properties of, 63.
- n -Diphenylcarbamyliourantoin, preparation and properties of, 63.
- Diphenylene disulphide, preparation and properties of, 183.
- Diphenylquinoxaline, preparation and properties of, 169.
- c -Diphenylthiobinuret, preparation and properties of, 63.
- Di-*isopropylsuccinic acids*, preparation and properties of symmetric, 149.
- Dipropylhydroxylamines, preparation of, 60.
- Dipyridyl, derivatives of, 98.
- Dissociation constants of weak acids, 208.
- Ditolylene disulphide, preparation of, 183.
- Ditolyglycerates, rotatory powers of, 105.
- Dynamic isomerism, 25.
- Elaidic acid, production from oleic acid, 191.
- Election of Fellows, 45, 113, 157, 223.
- Electrodes for producing absorption spectra, 49.
- Equilibrium, velocity of reaction before complete, 175.
- Equilibrium of isomerides, 76.
- Esterification constants of substituted acetic acids, 2.
- Ethoxynaphthalene derivatives, properties of, 210.
- Ethoxypropionic acids from lactic acids, rotatory power of, 74.
- Ethyl acetonedicarboxylate, condensation of, 151.
- ammoniumselenites, preparation and properties of, 101.
- ammoniumsulphite, preparation and properties of, 101.
- *isoamyl*acetoacetate, preparation and properties of, 163.
- α -bromomethylisopropylacetate, preparation and properties of, 225.
- Ethyl bromoglutarate, preparation and properties of, 241.

- Ethyl cyanacetate, action of trimethylene bromides on, 133.
 — cyanodimethylbutanetricarboxylate, preparation and properties of, 184.
 — $\alpha\alpha'$ -dibromobutanetetracarboxylate, preparation and properties of, 197.
 — $\beta\beta$ -dimethylpropanetetracarboxylate, preparation and properties of, 62.
 — phenylcarbamyliothiocyanate, and derivatives, preparation and properties of, 64.
 — γ -phenyl- $\alpha\alpha'$ -dihydroxy- β -carboxylate, preparation and properties of, 7.
 — phenylcyanobutanetricarboxylate, preparation of, 184.
 — phenylcyanoglutarate, preparation of, 184.
 — α -isopropylacrylate, preparation and properties of, 103.
 — tetrachloroacetonedicarboxylate, preparation and properties of, 9.
 — tetramethylenecyanocarboxylate, preparation and properties of, 134.
 — trimethylenecyanocarboxylate, preparation and properties of, 134.
 Ethyl- ψ - n -anisoilurea, preparation and properties of, 53.
 Ethyl- ψ - n -benzoylurea, preparation and properties of, 53.
 Ethylisopropylacetic acid, preparation and properties of, 225.
 Ethylisopropylmalonic acid, preparation of, 255.
 Explosion wave in carbon disulphide, velocity of, 114.
 Fatty acids, constitution of, 225.
 Fehling's solution, the blue salt of, 120.
 Fencholenic acid, preparation and properties of, 106.
 Fenchone, analogy between camphor and, 106.
 — action of sulphuric acid on, 196.
 Ferrous chloride, estimation of nitrites, &c., by, 50.
 Formaldehyde, action of hydrogen peroxide on, 158.
 — interaction of, with β -naphthylamine derivatives, 9.
 Finances of the Society, 82.
 Fischer, congratulatory letter to Professor Emil, 235.
 Fractional distillation, stillheads for, 147.
 Furfural, oxidation of, by hydrogen peroxide, 130.
 Furfuran, aromatic derivatives of, 167.
 Gallotannic acid, optical activity of, 67.
Genista tinctoria, colouring matter of, 179.
 Genistein, preparation and properties of, 179.
 Glucose, estimation of, in hydrolysis products, 13.
 Glucosides, 196.
 Glucosone, preparation from various carbohydrates, 99.
 Glycollic aldehyde, preparation and properties of crystalline, 119.
 Gossypetin, preparation and properties of, 161.
Gossypium herbaceum, colouring matter of, 161.
 Groves, C. E., retirement of, from Editorship of the Journal, 46.
 Hæmatoxylin, constitution of, 76.
 Heat of combination of copper with zinc, 195.
 Hexamethylene, critical constants of, 182.
 Homocamphoronic acid, preparation and properties of, 159.
 Hydrazinesalicylic acid, preparation and properties of, 231.
 Hydrindamine salts, isomerism of, 172.
 Hydrocyanic acid, production of, from potassium ferrocyanide, 226.
 Hydrogen, boiling point of, 70.
 — peroxide, constitution of, 148, 159.
 — — action of on carbohydrates, 99.
 — — action of on furfural, 130.
 Hydrosulphides of potassium and sodium, 146.
m- and *p*-Hydroxybenzodiphenylfuran, preparation and properties of, 168.
o- and *p*-Hydroxybenzylidenebornylamine, 194.
 Hydroxyfurfural, preparation and properties of, 130.
 Hydroxylamines, reaction of alkyl iodides with, 58.
p-Hydroxyphenylacetic acid, preparation and properties of, 179.
 Hydroxypyromucic acid, preparation and properties of, 130.
 Induline dyes, electrolytic preparation of, 194.
 Iodine, preparation of pure, from nitrogen iodide by Stas, 21.
 Iron, spectrum of, for use in investigations of absorption in the ultraviolet, 49.
 Isatin, constitution of, 48.

- Isoamarine, constitution of, 212.
 — resolution of, 228.
 Isocamphoric acid, constitution of, 184.
 Isomeric changes of benzenesulphonic acids, 16.
 Isoparaffins, separation of, from normal paraffins, 22.

 Japaconitine, preparation and properties of, 206.
 Japbenzaconine, preparation and properties of, 207.

 α -Ketotetrahydronaphthalene, preparation and properties of, 4.

 Lauronic acids, constitution of, 24.
 ψ -Lauronic acid, preparation and properties of, 24.
 Lead, solubility of, in acid waters.
 Library catalogues, list of former, 80.
 Lime, carbonate of, purification of water by, 2.
 Luteolin, constitution of, 242.

 Malic acid, preparation of active ethereal alkylxysuccinates from, 6.
 Malic acids, rotation of ethereal salts of substituted, 26.
 Malt, enzymes of, 15.
 Maltodextrin, constitution of, 11.
 Maltodextrinic acids, A and B, preparation and properties of, 12.
 Maltose, constitution of, 16.
 Mandelic acid, properties of, 186.
 — — optical activity of replaced, 150.
 Mercuric iodide sulphides of the fatty series, 240.
 — and sodium nitrites, and interaction of, 103.
 Mercurous iodide, 239.
 — nitrite and ethyl iodide, interaction of, 239.
 — and silver nitrites, interaction of, 103.
 Mercury-aluminium couple, 183.
 Metahemipinic acid, preparation and properties of, 241.
 Methoxynaphthalene derivatives, properties of, 210.
 Methoxy-vitexin (scoparin), 123.
 Methylisocamylsuccinic acid, preparation and properties of, 163.
 Methyl- ψ -*n*-benzoylurea, preparation and properties of, 53.

n-Methyl-*p*-dibenzylthiourea, preparation and properties of, 54.
a-Methyl-*c*-diphenylthiobiuret, properties of, 63.
 Methylene-1-bromo-2-naphthylamine, preparation and properties of, 10.
 Methyl bromodihydro- ψ -lauronolate, preparation and properties of, 24.
 Methylglyoxal-*p*-ethoxyphenyl-hydrazoxime, osazone, and osotetrazone, preparation and properties of, 230, 231, 231.
 Methylglyoxalmethylphenyl-phenylosazone, preparation and properties of, 232.
 Methylglyoxalsalicylic acid osazone, preparation and properties of, 231.
 Methyl ψ -lauronolate, preparation and properties of, 24.
n-Methyl-*p*-methylbenzylthiourea, preparation and properties of, 54.
a-Methylphenylcarbamyl- β -phenylthiosemicarbazide, preparation and properties of, 64.
 Methylsuccinic acids, preparation of unsymmetrical, 5.
 Mixtures, refractive powers of, 238.
 Molybdictrates, preparation and properties of alkaline, 107.
 Molybdilactic acid, preparation and properties of potassium salt, 108.
 Molybdimalates, preparation and properties of alkaline, 107.
 Molybdimucates, preparation and properties of, 107.

 Naphthalene vapour, maximum pressure of, 123.
 β -Naphthol derivatives, etherification of, 210.
 $\beta\beta$ -Naphthol-glucoside, preparation and properties of, 196.
 Negative acid radicals, influence on substitution, 177.
 Nitrates, estimation of, 50.
 Nitrites, interaction of, 103.
 — estimation of, 50.
o- and *p*-Nitrobenzylidenebornylamine, 194.
 Nitrocamphor, change of rotatory power of, 25.
 Nitrogen, atomic weight of, 213.
 — influence of, on substitution, 176.
 — interaction of oxides of, 116.
 — optically active compounds of, 192.
 — asymmetric, compound of bornylamine containing, 72.
 — quinquivalent, 172.
 — chlorides, substituted, 152, 232.
 — iodide, composition of, 18.

Nitrogen iodide, preparation and properties of, 17.

— — — an endothermic substance, 21.

— — — action of reducing agents on, 17.

— — — action of light on, 18.

— — — action of alkaline hydrates, water, and hydrogen peroxide on, 19.

— — — action of acids on, 19.

— — — reactions and constitutions of, 20.

Nitrophenols, constitution of salts of, 122.

Nitrous anhydride, gaseous, 116.

Nomenclature of carbo-nitrogen cyclic compounds, 191.

Officers, election of, 85.

Oleic acid, action of nitric acid on, 190.

Oleo-resin of *Dacryodes hexandra*, 150.

Optical activity and position isomerism, 105.

— — — of bornylamine derivatives, 194.

Osazones, some new, 229.

Oxalacetic acid, preparation of, 224.

Oxalic acid, condensation of, with resorcinol, 100.

Oxanilylisoithiocyanate, preparation and properties of, 65.

Oxygen, quadrivalence of, 148.

Oxysuccinic acids, production of optically active, from malic and tartaric acids, 6.

d-Pentacetylglucose, preparation and properties of, 196.

Phenacylaminophenanthrone, preparation and properties of, 167.

Phenacylhydroxyphenanthrone, preparation and properties of, 167.

Phenanthraquinone, derivatives of, 166.

α -Phenethylamine platinichloride, properties of, 200.

dl- α -Phenethylamine *d*-camphorsulphonate, preparation and properties of, 200.

Phenoketoheptamethylene, synthesis of, 174.

Phenoketoheptamethylenesemicarbazone, preparation and properties of, 174.

Phenolic salts of dibasic acids, preparation and properties of, 121.

Phenylalkylacetic acids, preparation and properties of active and inactive, 149.

Phenylbenzimidazole, preparation and properties of, 169.

Phenylbenzoylnitrogen chloride, preparation and properties of, 153.

γ -Phenyl- β -benzyl- $\alpha\alpha'$ -dihydroxypyridine, preparation and properties of, 7.

Phenylbutanetricarboxylic acids, 185.

Phenyldihydroxypyridine, preparation and properties of, 7.

Phenylformyl nitrogen chloride, preparation and properties of, 153.

n-Phenyl- ν -methylbenzylthiourea, preparation and properties of, 54.

Phosphorus, allotropic modifications of, 102.

— — — so-called suboxide of, 186.

Phosphorescent combustion of carbon disulphide, 115.

Polyazo-compounds, 196.

Polysulphides of potassium and sodium, preparation and properties of, 147.

Position-isomerism and optical activity, 25, 105.

Potassium ferrocyanide, action of sulphuric acid on, 226.

— — — imidoanisolithiocarbonate, preparation and properties of, 53.

President's address, 77.

Propylbenzenesulphonic acids, preparation and properties of, 16.

β -iso Propylglutaric acid, preparation and properties of, 104.

Propoxynaphthalene derivatives, properties of, 210.

Pseudocampholactone, 23.

Pseudourea, formation of, 52.

Pun, criticism of his results, 185.

Purpurine, preparation and properties of monomethyl derivative of, 66.

Pyridine derivatives, some, 170.

— — — chlorine derivatives of, 187, 205.

Pyrojoapaconine, preparation and properties of, 207.

Pyrojoapaconitine, preparation and properties of, 207.

α -Pyrone compounds, formation of, 55.

Racemic compounds, characterisation of, 73.

— — — liquids, characterisation of, 200.

Resorcinol, condensation of, with oxalic acid, 100.

Rotatory power of nitrocampher, 25.

— — — of ethoxypropionic acids from lactic acid, 74.

Rottlerine, decomposition products of, 162.

Saccharic acids, 199.

Saponification, theory of, 190.

Scoparein, preparation and properties of, 123.

Scoparin, preparation and properties of, 123.

Selenosamates, non-existence of, 101.

Silico-organic compounds, 174.

Sodium ethoxide as a reagent, 7.

Solutions, aqueous, change of volume due to dilution, 7.

— — — thermal changes due to dilution, 8.

- Specific rotation, influence of substitution in the bornylamine series on, 71.
- Stannic acid, preparation and properties of ammonium salt, 108.
- Stannitartrates, preparation and properties of alkaline, 108.
- Starch, complexity of constitution and rapidity of formation in plants contrasted, 14.
- derivatives, preparation of, through their nitrates, 13.
- Still-heads, efficiency of various, 147.
- Stokes, address to Prof. Sir G. G., 145.
- Substitution in benzenoid compounds, 176.
- Succinic acids, new method of preparing substituted unsymmetrical methyl, 5.
- Sucrose, estimation of, in presence of lactose, 9.
- Sulphates of the formula $R_2SO_4 \cdot 2MSO_4$, 227.
- Sulphides of potassium and sodium, 147.
- Sulphur chloride, action of, on aromatic hydrocarbons, 183.
- Sulphuric acid, decomposition of, by elements, 132.
- Sylvestrene, laevorotatory, 150.
- Tellurium, interaction of, with arsenic, 124.
- Terebic acid, synthesis of, 104.
- Terpenylic acid, synthesis and preparation of, 104.
- Tetrachloropyridines, constitution of, 205.
- Tetrahydrofurfuran- $\alpha\alpha'$ -dicarboxylic acid, preparation and properties of, 198.
- d*-ac-Tetrahydro- β -naphthylamine, preparation and properties of, 170.
- d*-ac-Tetrahydro- β -naphthylamine *d*- α -bromocamphorsulphonate, preparation and properties of, 170.
- Tetrahydroquinaldines, 124.
- Tetrahydroquinaldine, resolution of, 199.
- l*-Tetrahydroquinaldine, preparation and properties of, 125.
- *d*- α -bromocamphorsulphonate, preparation and properties of, 125.
- d*- and *l*-Tetrahydroquinaldine *d*-camphorsulphonate, preparation and properties of, 125.
- Tetrahydro-*p*-toluquinaldine, resolution of, 200.
- l*-Tetrahydro-*p*-toluquinaldine, preparation and properties of, 171.
- Tetramethyl- $\beta\beta$ -diaminodiphenylmethane, preparation and properties of, 10.
- Tetramethylhæmatoxylin, preparation and properties of, 28, 241.
- Tetramethylhæmatoxylone, preparation and properties of, 28, 241.
- Tetrazoline, formation of, 191.
- Thermal effects of dilution, 8.
- Thiobiurets, new method of producing, 62.
- Thiocyanates, action of metallic, 62.
- Tiemann's saccharic acids, 199.
- Titanic acid, preparation and properties of potassium salts, 108.
- Titanimucic acid, preparation and properties of potassium salts, 108.
- Titanitartrates, preparation and properties of alkaline, 108.
- a*-*o*- and *p*-Tolyl-*c*-diphenylthiobiuret, preparation and properties of, 63.
- Transition temperatures, determination of, 210.
- $\alpha\alpha'$ - π -Tribromocamphor, preparation and properties of, 61.
- Trichlorophenylacetylnitrogen chlorides, 232.
- Triethyl orcintricarboxylate, constitution of, 151.
- Triethyloxamine, preparation and properties of, 60, 124.
- Trihydroxyphenylketocumaran, 179.
- Trimethylbrazilin, preparation and properties of, 27.
- Trimethylbrazilone, preparation and properties of, 27.
- Trimethylmethoxyammoniumhydroxide, preparation and properties of, 59.
- Triethyloxamine, preparation and properties of, 59, 124.
- Trinitrobenzoic acid, description of, 4.
- Triphenylazalone, preparation and properties of, 165.
- Triphenylsilicol, preparation and properties of, 174.
- Triphenylsilyl acetate, 174.
- ether, preparation and properties of, 174.
- acc-Triphenylthiobiuret, preparation and properties of, 63.
- Tungstictrates, preparation and properties of, 107.
- Tungstimulates, preparation and properties of, 107.
- Tungstimucic acid, preparation of potassium salt, 108.
- Tyrosin, absorption spectrum of, 175.
- Velocity of reaction, 175.
- Volume changes due to dilution of solutions, 7.
- Vörlander's reaction, 52.
- Water, acidity of moorland, 1.
- Xylidenes, separation of isomeric, 202.

PROCEEDINGS
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January 19th, 1899. Professor Dewar, F.R.S., President, in the Chair.

Messrs. W. Ackroyd, E. M. Rich, and C. W. T. Woods were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. Robert Alfred Bolam, 31, Oxford Street, Newcastle-on-Tyne; James Washington Epps, 95, Upper Tulse Hill, S.W.; Ernest Barratt Fairweather, King's College Hospital, Lincoln's Inn Fields, W.C.; Colin Charlwood Frye, Burwood, Woodville Road, Ealing, W.; Edmund Vivian Gabriel, Bengal United Service Club, Calcutta; Harold Brewer Hartley, Romney Lodge, New Park Road, Clapham Park, S.W.; Tom Lacey Hewitt, Beech Field, St. John's, Higher Broughton, Manchester; Edward Flaxman Linstead, 35, Hayter Road, Brixton Hill, S.W.; Thomas Mackenzie, 8, Gardner Street, Glasgow; Joshua Maudsley, Merchiston Castle, Edinburgh; Arthur Mirrlees, Redlands, Kelvinside, Glasgow; Bernhard Mohr, 69A Parliament Hill, Hampstead, N.W.; John Cavendish Molson, 42, Sackville Road, Hove, Brighton; John Trengove Nance, District Bank, Newcastle, Staffs.; William Walker Scott Nicholls, 230, Brockley Road, Brockley, S.E.; Horace Seymour Pyne, Castletown, Isle of Man; Arnold Stevenson, 4, Porchester Gardens, S.W.; Henry Fox White, Warnham, Woodland Road, Clifton, Bristol.

Of the following papers, those marked * were read:—

- *1. "Researches on moorland waters. I. Acidity." By William Ackroyd, F.I.C.

Moorland waters are consumed by over five and a quarter millions of people in England. The quality of acidity possessed by these waters,

which has been associated with plumbo-solvent action, is therefore of great importance. The author differentiates between organic and inorganic acidity, and describes a method for ascertaining their amounts which consists of (1) titration with N/100 alkali, using phenolphthalein as indicator, and (2) aspiration of air free from carbon dioxide through another portion, and a second titration for the residual acidity. The precautions to be used are described.

Data are given showing the loss of acidity due to diffusion in observations extending over 181 days. Comparisons are made proving that the differences in acidity of waters from various gathering grounds are due to differences of gradient. It is finally shown that the organic acid in solution, always assumed to be humic acid, is of lower equivalent than that of the lowest humic acid known.

DISCUSSION.

The PRESIDENT said that the plumbo-solvent action of the water supplied to Sheffield, Bradford, and Huddersfield, had been overcome by the addition of finely precipitated carbonate of lime in the reservoirs, with the result that the quality of the water was improved, not only by removal of the acidity, but also indirectly by precipitation of the dissolved peaty matter.

*2. "Esterification constants of substituted acetic acids."

By John J. Sudborough and Lorenzo L. Lloyd.

Goldschmidt has shown (*Ber.*, 1895, 23, 3218) that the esterification of an organic acid in the presence of a catalytic agent, such as hydrogen chloride and of a considerable excess of alcohol, may be regarded as a monomolecular reaction, and may, therefore, be represented by the equation, $\frac{dx}{dt} = K(-x)$, which, on integration, gives

$K = \frac{1}{t} \log_e \frac{a}{a-x}$, where a is the initial concentration of the acid, $a-x$ the concentration of the acid after time t , and K the esterification constant. According to Goldschmidt, and also according to experiments made by the authors, K is directly proportional to the amount of hydrogen chloride present when dilute solutions are employed. In all cases K is calculated for normal hydrogen chloride.

The authors suggest that the letter E be used for the esterification constant, as K is already employed to denote the dissociation constant of an acid. E would then represent the esterification constant of an acid when normal hydrogen chloride is used, and $E_{EtOH}^{10^\circ}$ would represent the esterification constant of an acid with ethylic alcohol and a normal solution of hydrogen chloride at a temperature of 10° .

In the authors' experiments, N/40 hydrogen chloride was employed, and the organic acid was practically N/10 in all cases. Equal volumes of N/5 solutions of the acid in 100 per cent. ethylic alcohol, and of N/20 hydrogen chloride in 100 per cent. alcohol, were mixed, and 30 c.c. of the mixture run into small, stoppered bottles, and maintained at a temperature of 14.5°. The contents of these bottles were then titrated with N/10, and finally with N/20 alkali, phenolphthalein being employed as indicator. The constants were calculated from the equation, and the results are given in the following table, together with the dissociation constants where known.

Acid.	Formula.	$E_{EtOH}^{14.5^\circ}$	K.
Acetic	$CH_3 \cdot CO_2H$	3.661	0.00180
Propionic.....	$CH_3Me \cdot CO_2H$	3.049	0.00134
Chloracetic.....	$CH_2Cl \cdot CO_2H$	2.432	0.155
Phenylacetic.....	$CH_2Ph \cdot CO_2H$	2.068	
Bromacetic	$CH_2Br \cdot CO_2H$	1.994	0.133
Iodacetic	$CH_2I \cdot CO_2H$	1.713	0.075
Isobutyric.....	$CHMe_2 \cdot CO_2H$	1.0196	0.00144
Trimethylacetic	$CMe_3 \cdot CO_2H$	0.0909	0.000978
Dichloracetic.....	$CHCl_2 \cdot CO_2H$	0.0640	5.14
Diphenylacetic.....	$CHPh_2 \cdot CO_2H$	0.05586	
Dibromacetic	$CHBr_2 \cdot CO_2H$	0.0510	
Trichloracetic.....	$CCl_3 \cdot CO_2H$	0.0372	121.0
α -Bromoisobutyric	$CMe_2Br \cdot CO_2H$	0.0356	
$\alpha\alpha$ -Dibromopropionic.....	$CMeBr_2 \cdot CO_2H$	0.0242	3.3
Tribromacetic	$CBr_3 \cdot CO_2H$	0.01345	

It thus appears that the rate of esterification depends on the constitution of the acid rather than on its strength. The authors are engaged in determining the esterification constants of substituted acrylic acids, and hope to extend the work to other series.

***3. "Diortho-substituted benzoic acids. Part IV. Formation of salts from diortho-substituted benzoic acids and different organic bases." By Lorenzo L. Lloyd and John J. Sudborough.**

In continuation of their work on diortho-substituted benzoic acids (*Trans.*, 1895, 67, 588 and 601; 1897, 71, 229), the authors have attempted to prepare salts from 2:4:6-trinitrobenzoic, 2:4:6-tribromobenzoic, 2:4:6-tribromo-3-aminobenzoic, metanitrobenzoic, and benzoic acids, and the following bases: trimethylamine, tripropylamine, tribenzylamine, diethylaniline, aniline, metabromaniline, metanitr-aniline, 2:4- and 2:6-dibromaniline, pseudocumidine, mesidine, diphenylamine, and α - and β -naphthylamines, with results which are described in the paper. The investigation was undertaken in order

to determine whether the capacity to form salts is dependent on (1) the strength of the acid and of the base, or (2) the constitution of the acid and of the base, or on both of these.

It was thought probable that a tertiary base of high molecular weight might not be able to combine with a diortho-substituted acid, but the reverse has proved to be the case. Bases such as tribenzylamine, metanitriline, &c., which will not combine with benzoic acid, readily combine with such diortho-substituted derivatives as 2:4:6-trinitrobenzoic, 2:4:6-tribromobenzoic, and 2:4:6-tribromo-3-amino-benzoic acids. This behaviour can only be accounted for by the fact that these are much stronger acids than benzoic, and combination between substituted benzoic acids and different bases would, therefore, appear to depend entirely on the strength of acid and strength of base.

Combination could not be effected between benzoic acid and metabromaniline, diethylaniline, pseudocumidine, or tribenzylamine, between metanitrobenzoic acid and tribenzylamine, and between trinitrobenzoic or tribromaminobenzoic acids and 2:4- or 2:6-dibromaniline, or diphenylamine.

The salts of trinitrobenzoic acid have no well-defined melting points; when heated, they become dark coloured, then melt and decompose, the temperature at which this occurs depending on the mode of heating. Most of the other salts have well-defined melting points.

***4. "α-Ketotetrahydronaphthalene." By F. Stanley Kipping, D.Sc., F.R.S., and Alfred Hill.**

The reaction involved in the synthesis of α-hydrindone from phenylpropionic chloride by means of aluminium chloride (*Trans.*, 1894, 65, 480) is probably capable of wide application, and the authors have commenced experiments recently with the object of studying its usefulness in various directions. It has been found that when phenylbutyric chloride is treated with aluminium chloride under suitable conditions, it is converted into α-ketotetrahydronaphthalene by intramolecular condensation, $C_6H_5 \cdot CH_2 \cdot CH_2 \cdot CH_2 \cdot COCl = C_6H_4 \left\langle \begin{smallmatrix} CH_2 \cdot CH_2 \\ CO \cdot CH_2 \end{smallmatrix} \right\rangle + HCl$; a reaction which is exactly analogous to that by which α-hydrindone is prepared.

α-Ketotetrahydronaphthalene is a colourless, highly refractive liquid, having a slight odour, faintly recalling that of both camphor and peppermint. The semicarbazone, $C_{10}H_{10} \cdot N \cdot NH \cdot CO \cdot NH_2$, crystallises from alcohol in yellow needles or prisms, melts and decomposes at 217—220°, and is sparingly soluble in cold alcohol; when heated with dilute hydrochloric acid, it is decomposed, the ketone being regenerated. The phenylhydrazone, $C_{10}H_{10} \cdot N \cdot NHPh$, crystallises from methylic

alcohol in massive, transparent plates melting at $84-85^{\circ}$; it is readily soluble in most ordinary solvents and is very unstable in the air. The *parabromophenylhydrazone*, $C_{10}H_{10}:N \cdot NH \cdot C_6H_4Br$, separates from alcohol and other solvents in long, colourless prisms and melts at $117-118^{\circ}$; it is more stable than the hydrazone, but, like the latter, is decomposed by hot hydrochloric acid, the product being probably analogous to that obtained from the hydrazone of α -hydrindone in a similar manner. The *oxime*, $C_{10}H_{10}:N \cdot OH$, separates from cold methylic alcohol in very large, well-defined, rhomboidal crystals; it melts at $102.5-103.5^{\circ}$, and is readily soluble in most ordinary solvents, but insoluble, or nearly so, in water. When reduced with sodium amalgam in acetic acid solution, the oxime is converted into a base, which is doubtless identical with the tetrahydro- α -naphthylamine described by Bamberger and Bammann (*Ber.*, 1889, 22, 951).

***5. "A new method for preparing unsymmetrical dimethyl- and trimethyl-succinic acids." By William A. Bone.**

When ethylic sodiomalonate or ethylic sodiomethylmalonate is treated with ethylic α -bromisobutyrate in alcoholic solution, a mixture of ethylic salts of tricarboxylic acids is obtained. This, on hydrolysis with concentrated hydrochloric acid, yields a mixture of isomeric methyl derivatives of succinic and glutaric acids, in which, however, the glutaric acid very largely preponderates, the yield of the isomeric succinic acid being very small.

This is due to the fact that, in presence of the strongly alkaline solution, the ethylic α -bromisobutyrate readily loses hydrogen bromide, forming ethylic methacrylate, which then condenses with the ethylic malonate, or ethylic methylmalonate, according to the equation $(CO_2Et)_2CH_2 + CH_2:CM_e \cdot CO_2Et = (CO_2Et)_2CH \cdot CH_2 \cdot CHMe \cdot CO_2Et$, and the resulting ethereal salt, on hydrolysis with concentrated hydrochloric acid, yields a methyl derivative of glutaric acid.

The author has found that if the sodium derivative of ethylic cyanacetate, which is almost insoluble in alcohol, be heated with an alcoholic solution of ethylic α -bromisobutyrate, the latter apparently does not lose hydrogen bromide, forming ethylic methacrylate, but reacts quite normally with the ethylic sodiocyanacetate, according to the equation $(CO_2Et)(CN)CHNa + BrCMe_2 \cdot CO_2Et = (CO_2Et)(CN)CH \cdot CMe_2 \cdot CO_2Et + NaBr$, and a very good yield of unsymmetrical ethylic dimethylcyano-succinate is obtained. This, on hydrolysis with concentrated hydrochloric acid, yields practically the theoretical quantity of an acid melting at $139-140^{\circ}$, the composition and properties of which are identical with those of unsymmetrical dimethylsuccinic acid.

Unsymmetrical ethylic dimethylcyanosuccinate contains a hydrogen

atom replaceable by sodium. The sodium compound, which is soluble in alcohol, readily reacts with methylic iodide, yielding ethylic trimethylcyanosuccinate, and this, on hydrolysis with concentrated hydrochloric acid, is converted into trimethylsuccinic acid.

By means of these reactions, unsymmetrical di- and tri-methylsuccinic acids can be readily prepared in quantity. It is probable, moreover, that any mono-, di-, or tri-alkyl derivative of succinic acid may be prepared by starting with ethylic cyanacetate, and working on the lines indicated, the author is, therefore, making a special study of these reactions.

6. "Production of optically active mono- and di-alkyloxysuccinic acids from malic and tartaric acids." By Thomas Purdie, F.R.S., and William Pitkeathly, B.Sc.

In continuation of a previous research (*Trans.*, 1898, '73, 287), the authors have made further observations on the production of the ethereal alkyloxysuccinates in the interaction of silver malate and alkyl iodides. Small quantities only of these compounds were formed in the cases examined. A similar abnormal reaction occurs between silver tartrate and isopropyl iodide, an active ethereal salt of di-isopropoxysuccinic acid being found in the product; other alkyl iodides no doubt act in the same manner, though probably to a smaller extent.

The alcoholic hydroxyl groups of ethylic malate and tartrate are readily and completely alkylated by ethylic iodide in the presence of silver oxide. Diethoxysuccinic acid, obtained by this method, is a crystalline, highly dextrorotatory compound. The observations made on the rotatory powers of this acid and its ethylic, barium, and sodium salts furnish an explanation of the apparently anomalous results obtained by Rodger and Brame in preparing the alkylic tartrates from the silver salt (*Trans.*, 1898, '73, 301).

The method of alkylation by means of alkyl iodides and silver oxide, which does not appear to have been used previously, is generally applicable to the ethereal salts of hydroxy-acids, and probably also to other substances of a similar nature. As racemisation does not occur in the process, it is specially adapted for the preparation of optically active compounds.

7. "The action of ammonia on ethereal salts of organic acids."

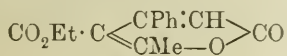
By Siegfried Ruhemann.

This paper is a continuation of the author's researches on the formation of pyridine derivatives from unsaturated acids. The ethylic salts of these acids have been prepared by the interaction of sodium ethoxide with a mixture of the salts of the acids of the malonic series

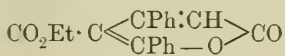
and those containing an acetylene linkage. Ethylic phenylpropenetricarboxylate, on treatment with ammonia, is converted into *ethylic γ-phenyl-αα'-dihydroxy-β carboxylate*, crystallising in colourless prisms melting at 200°, and *phenyldihydroxypyridine*, $\text{CPh} \begin{smallmatrix} \text{CH} \cdot \text{C}(\text{OH}) \\ \text{CH} \cdot \text{C}(\text{OH}) \end{smallmatrix} \text{N}$, melting at 254—255°. Ethylic phenylbenzylglutaconate has been prepared from the product of the interaction of ethylic benzylmalonate and ethylic phenylpropiolate; on treatment with ammonia, it yields *γ-phenyl-β-benzyl-αα'-dihydroxypyridine* melting at 175°.

The author, further, gives an account of some experiments undertaken with the view of examining the action of ammonia on ethylic salts of saturated polycarboxylic acids. Ethylic propanetetracarboxylate is transformed into the diamido-imide of the acid (Ruhemann and Cunningham, *Trans.*, 1898, 73, 1006), but its homologue, ethylic β-methylpropanetetracarboxylate, forms the tetramide. Ethylic propanepentacarboxylate yields the triamido-imide of the acid, $\text{NH} \begin{smallmatrix} \text{CO}-\text{CH}-\text{CONH}_2 \\ \text{CO}-\text{CH}-\text{CH}(\text{CONH}_2)_2 \end{smallmatrix}$, melting at 212°, but ethylic phenylpropanetricarboxylate is transformed into the triamide melting at 230° with evolution of gas.

The author has also examined the action of sodium ethoxide on a mixture of ethylic phenylpropiolate with ethylic acetoacetate on the one hand, and with ethylic benzoylacetate on the other, and shows that the α-pyrone compounds, represented by the formulæ I and II, are formed respectively.



I. M. p. 104°.



II. M. p. 120—121°.

The action of ammonia on the first of these compounds has been studied; it does not lead to the formation of a pyridine derivative, but yields the ammonium salt, $\text{NH}_2 \cdot \text{CMe} \cdot \text{C}(\text{CO}_2\text{Et}) \cdot \text{CPh} \cdot \text{CH} \cdot \text{CO}_2\text{NH}_4$, which regenerates the pyrone compound on treatment with acids.

8. "The changes of volume due to dilution of aqueous solutions." By E. B. H. Wade, B.A.

In this paper, the contraction of solutions of different substances at various concentrations has been studied experimentally. Contraction is defined as the diminution of volume on mixing equal volumes of water and solution, stated for 100,000 c.c. of resulting solution; e.g., if 50 c.c. of water + 50 c.c. of solution yield 99.999 c.c. of diluted solution, the contraction is said to be unity. Concentration is defined as the number of gram equivalents of substance in every 100,000 c.c. of the solution after dilution.

The author describes an apparatus for measuring such contractions directly to within about one-tenth of a unit without the need of determining the specific gravities of the experimental liquids. Observations were made on solutions of hydrogen, sodium, potassium, calcium, and strontium chlorides, potassium ferrocyanide, oxalic acid, cane-sugar, and urea. In almost all cases the equation $X = \frac{n^b}{a}$ was found to hold good in which X is contraction, n concentration, and a , b are constant terms. In such cases Φ , the apparent volume of the substance, must be given by $\Phi = \text{const.} + \frac{n^b - 1}{a(2^b - 1)}$, and values of Φ thus calculated for various values of n are tabulated in the paper.

The first equation shows how X varies with the concentration. If the concentration be kept constant, and the dissolved substance varied, it is found that X increases regularly with the equivalent weight of the dissolved substance.

The apparatus described is available for many other cases where a change of volume follows a chemical process, as in the neutralisation of an acid.

9. "The thermal effects of dilution." By J. Holms Pollok, B.Sc.

In thermo-chemical determinations, it is customary to operate with very dilute solutions to simplify the calculations connected therewith. To determine how far dilution might affect the thermal condition of salts in solution, a number of saturated solutions of salts were diluted with an equal bulk of water, and the following changes of temperature were noted.

Saturated solutions at 9°.	Thermal change on dilution.		Saturated solutions at 9°.	Thermal change on dilution.	
	1st Expt.	2nd Expt.		1st Expt.	2nd Expt.
NaCl	+0.50	+0.50	(NH ₄) ₂ SO ₄	-0.43	-0.39
NaNO ₃	-1.80	-1.85	CaCl ₂	+0.58	+0.62
Na ₂ SO ₄	-0.05	-0.03	BaCl ₂	-0.07	-0.06
Na ₂ CO ₃	-0.15	-0.20	MgSO ₄	+0.02	-0.01
KCl	-0.47	-0.47	ZnSO ₄	+0.03	+0.05
KNO ₃	-0.32	-0.38	CuSO ₄	+0.02	+0.05
K ₂ SO ₄	-0.04	-0.03	FeSO ₄	+0.04	+0.00
K ₂ CO ₃	-0.37	-0.44	Pb(NO ₃) ₂	-0.37	-0.33
NH ₄ Cl	-0.15	-0.13			

The method employed was as follows: saturated solutions of the various salts were made, and half a litre of each placed in

glass bottles of that capacity ; an equal number of bottles were filled with half a litre each of distilled water, then all were placed in a large, shallow, wooden tub in a room of uniform temperature, and left for 24 hours. A number of thin glass beakers of about a litre capacity, with glass stirring rods shaped into a ring at the end, were provided, also a mercury thermometer graduated into tenths of a degree, and reading easily to a quarter of each division, as well as a differential alcohol thermometer with only about 4° on the whole stem, and the graduations of which corresponded to less than 0.01° . The temperatures of the bottles were taken as the experiments were made and were found to be almost exactly 9° , though the different bottles did in point of fact vary as much as 0.05° , for which a proper correction was made. A bottle of solution and a bottle of water were then lifted out of the bath by a piece of flannel and poured simultaneously into a beaker standing on a thick piece of flannel, stirred up, and the temperature noted by both thermometers.

10. "Halogen derivatives of acetonedicarboxylic acid. Part I."
By Frederick W. Dootson, M.A.

This communication is a preliminary note of an investigation of the action of halogens on ethylic acetonedicarboxylate. By the action of dry chlorine, *ethylic tetrachloracetonedicarboxylate* has been obtained. This substance, after purification, is a colourless, crystalline compound which melts at $30-30.5^{\circ}$, and decomposes on hydrolysis with aqueous soda or potash. It reacts with alcoholic potash, forming dichloromalonic and dichloroacetic acids, and with ammonia yielding the amides of these acids. The action of bromine is very similar to that of chlorine.

11. "The detection and determination of sucrose in the presence of lactose." By Edwin Dowzard.

The method proposed by the author is based on the fact that sucrose is inverted by citric acid, whilst lactose is unaffected. The rotatory power of a solution of lactose is determined before and after treatment with citric acid. If the lactose is pure, the rotation remains unchanged, but if sucrose is present it is considerably decreased. The amount of sucrose is readily calculated from the decrease in rotation.

12. "Note on the interaction of formaldehyde with β -naphthylamine derivatives." By G. T. Morgan, B.Sc.

With a view of explaining the interactions which occur between formaldehyde and β -naphthylamine (*Trans.*, 1898, 73, 536), the author has investigated the action of this reagent on alkyl, benzyl, and halogen derivatives of the base.

Dibenzyl-β-naphthylamine, $C_{10}H_7N(CH_2Ph)_2$, crystallises from alcohol in colourless leaflets, and from ethylic acetate in clusters of hard, transparent prisms; it melts at 119—120°.

One compound only results when formaldehyde reacts with dialkyl- and dibenzyl-β-naphthylamine, two molecular proportions of the base condensing with one of the aldehyde to form a dinaphthylmethane derivative. The following compounds have been obtained: *tetramethyl-β-β-diaminodinaaphthylmethane*, $CH_2(C_{10}H_6NMe_2)_2$, which crystallises in transparent, colourless prisms melting at 144°, the *tetrethyl* derivative, $CH_2(C_{10}H_6NEt_2)_2$, which crystallises in large, colourless prisms and melts at 114°, and the *tetrabenzyl* derivative, $CH_2[C_{10}H_6N\cdot(CH_2Ph)_2]_2$, which forms lustrous leaflets melting at 164°.

The formation of these derivatives seems to be due to substitution in the contiguous α-position, as compounds of a different type are formed with methylene in the side chain when a halogen atom occupies this α-position.

Methylene 1-bromo-2-naphthylamine, $C_{10}H_6BrN\cdot CH_2$, is obtained when 1-bromo-2-naphthylamine is treated with formaldehyde in acetic acid or in alcoholic solution; it crystallises from benzene or chloroform in colourless needles, and melts, with decomposition, at 144—145°. The corresponding *chloro*-derivative, $C_{10}H_6Cl\cdot N\cdot CH_2$, obtained from 1-chloro-2-naphthylamine, crystallises in colourless needles and melts at 179—180°. Both substances are compounds of the anhydroformaldehyde type, and are converted into their generators on hydrolysis with acids, whilst the dinaphthylmethane bases are not altered under these conditions.

The investigation is being extended to other derivatives of β-naphthylamine.

At the next meeting, on Thursday, February 2nd, 1899, the following papers will be communicated:—

“Maltodextrin, its oxidation products and constitution.” By H. T. Brown, LL.D., F.R.S., and J. H. Millar.

“On attempts to prepare pure starch derivatives through their nitrates.” By H. T. Brown, LL.D., F.R.S., and J. H. Millar.

“An isomeride of amarine.” By H. Lloyd Snape, D.Sc., Ph.D., and Arthur Brooke, Ph.D.

“Propylbenzenesulphonic acids.” By G. T. Moody, D.Sc.

“The chemistry of the so-called nitrogen iodide. Parts I.—VII.” By F. D. Chattaway, M.A., K. S. P. Orton, M.A., and H. P. Stevens, B.A.

“Derivatives of dicyzylmesitylene.” By W. H. Mills and T. H. Easterfield.

“The action of chlorosulphonic acid on the paraffins and other hydrocarbons.” By Sydney Young, D.Sc., F.R.S.

PROCEEDINGS

OF THE

CHEMICAL SOCIETY.

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Vol. 15.

No. 203.

February 2nd, 1899. Professor Dewar, F.R.S., President, in the Chair.

Mr. F. W. Dootson was formally admitted a Fellow of the Society.

Certificates were read for the first time in favour of Messrs. James Herbert Allworthy, Laxton School, Oundle; Peter Auchinachie, 12, Mid Street, Keith, N.B.; Kendall Colin Browning, St. John's College, Cambridge; William Collingridge, Port Sanitary Office, Greenwich, S.E.; Archibald Glen Kidston Hunter, Dunedin, New Zealand; Lawrence Christopher Panting, 9, Beverley Road, Anerley, S.E.; Samuel Barnett Schryver, D.Sc., Ph.D., 27, Arundel Gardens, W.; Arthur John Shelton, 19, Sturry Street, Poplar, E.; Robert Tatlock Thomson, 156, Bath Street, Glasgow.

Of the following papers, those marked * were read :—

- *13. "Maltodextrin, its oxidation products and constitution." By Horace T. Brown, LL.D. F.R.S., and J. H. Millar.

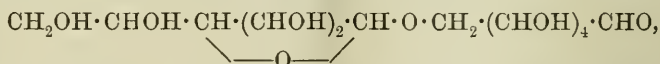
The subject of this paper is the maltodextrin which occurs amongst the intermediate products of starch hydrolysis with diastase, and to which the empirical formula $\begin{cases} \text{C}_{12}\text{H}_{22}\text{O}_{11} \\ (\text{C}_{12}\text{H}_{20}\text{O}_{10})_{1/2} \end{cases}$ has hitherto been assigned (Brown and Morris, *Trans.*, 1885, 47, 527). Although present in considerable quantities in starch-transformations which have been arrested at the right point, its preparation in a pure state, and in sufficient amount for extended work, is a very laborious process. When isolated, it was found to have properties corresponding to $[\alpha]_D$ 181—183, and R 42—43, and was completely hydrolysed to maltose by diastase, and to *d*-glucose by acids.

When maltodextrin is carefully oxidised with mercuric oxide and barium hydroxide until its power of reducing Fehling's solution disappears, the greater part of the product is obtained as the barium salt of a definite and complex carboxylic acid, which is provisionally called *maltodextrinic acid A*. This has been isolated. Its properties correspond to $[\alpha]_D$ 192.3, R 0, and its calcium salt contains 2.4 per cent. of calcium. Maltodextrinic acid A is hydrolysed both by diastase and by dilute acids. Under the action of diastase, it yields 40 per cent. of maltose, and 60 per cent. of another carboxylic acid of less complexity; this is *maltodextrinic acid B*, the calcium salt of which contains 3.8 per cent. of calcium.

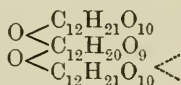
When hydrolysed by dilute oxalic acid, maltodextrinic acid A yields 85.8 per cent. of *d*-glucose, and another still simpler acid which is shown to be a C_5 -derivative. Maltodextrinic acid B, when hydrolysed by oxalic acid, also yields this same C_5 -acid and 67.7 per cent. of glucose.

The final C_5 -acid corresponds in composition to $C_5H_{10}O_6$, and appears to be a normal carboxylic acid derived from a pentose. Since this acid can now be prepared in fair quantities by the oxidation of maltose with mercuric oxide, the authors expect to be able very soon to put its exact nature beyond doubt. It has many properties in common with those of xylonic acid.

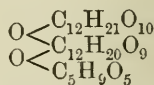
If the constitutional formula of maltose is taken as



the polysaccharide maltodextrin may be regarded as being made up of three such molecules with the elimination of the elements of $2H_2O$. Written in an abbreviated form, the formulæ of maltodextrin and of maltodextrinic acid A may be expressed thus:



Maltodextrin.

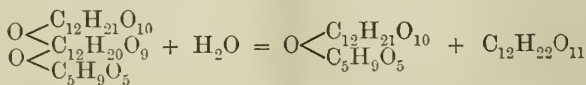


Maltodextrinic acid A.

the sign $\begin{smallmatrix} \diagup \\ \diagdown \end{smallmatrix}$ being used to denote the open carbonyl.

The hydrolysis of maltodextrinic acid A in two successive steps by diastase and acids respectively may be represented in the following manner.

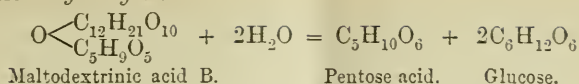
(1) *Diastase hydrolysis.*



Maltodextrinic acid A.

Maltodextrinic acid B.

Maltose.

(2) *Acid hydrolysis.*

In an appendix to the paper, the authors describe the standard methods they now employ to determine the amount of glucose which a carbohydrate or its derivative yields on complete hydrolysis with oxalic acid. The results of thus hydrolysing soluble starch, maltose, maltodextrin, and maltobionic acid are given.

***14. "On attempts to prepare pure starch derivatives through their nitrates." By Horace T. Brown, LL.D., F.R.S., and J. H. Millar.**

This paper records the efforts made by the authors to obtain some of the hydrolytic products of starch in a pure state by preparing their nitric esters and regenerating them by treatment with ammonium sulphide.

Although perfectly successful as regards soluble starch, it was not found possible to regenerate from their nitrates substances like maltodextrin, amyloextrin, and the stable dextrin, the recovered product always showing signs of having undergone some oxidation during the nitration process. All the reducing starch-products, *i.e.*, those with an open carbonyl group, yield on nitration and regeneration indeterminate mixtures containing carboxylic acids.

***15. "The stable dextrin of starch transformations, and its relation to maltodextrin and to soluble starch." By Horace T. Brown, LL.D., F.R.S., and J. H. Millar.**

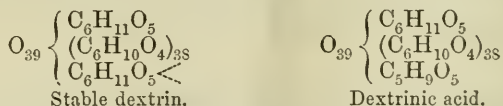
When starch is transformed by an active diastase, such as that derived from an air-dried malt, at temperatures below 60°, the reaction proceeds with great rapidity until a resting stage is reached corresponding to $[\alpha]_D$ 150, R 80, for the mixed products of change. At this stage, these products consist of maltose, and a dextrin which, comparatively speaking, is very resistant to the further action of the hydrolytic agent. An account is given of the mode of separation, and the dextrin was obtained ultimately with optical and reducing properties corresponding to $[\alpha]_D$ 195—195·7, and R 5·7 to 5·9. This residual reducing power is a property inherent to the dextrin, and is not due to admixture with a second reducing substance. This was shown by oxidising the dextrin with mercuric oxide and baryta, a definite dextrinic acid being produced.

Dextrinic acid is a complex carboxylic acid with distinct but feeble acid properties. It forms a well-defined calcium salt, containing

0.31 per cent. of calcium, and under the influence of acid hydrolysis yields *d*-glucose and a residual C_5 -acid, which is shown to be identical with that obtained by the complete acid hydrolysis of the two maltodextrinic acids already described. The amount of glucose given by this hydrolysis has been determined.

Dextrinic acid and its salts, and also the dextrin from which it is derived, unlike maltodextrin and maltodextrinic acid A, are but very slowly hydrolysed by diastase. After many hours' treatment at $50-60^\circ$, a certain limited amount of change takes place, the resulting products being maltose and glucose in about equal proportions. The glucose is not derived from previously formed maltose, since it is observed when a malt-extract absolutely devoid of any maltose-hydrolysing power is employed.

The available evidence all points to the conclusion that the stable dextrin and the derivative polysaccharide acid, dextrinic acid, are built up of C_6 -, and not, as in the case of maltodextrin, of C_{12} -groups. The dextrin molecule may be empirically regarded as made up of 39 $C_6H_{10}O_5$ groups in combination with a terminal $C_6H_{12}O_6$ group; or, more correctly, as a condensation of 40 glucose molecules, with the elimination of $39H_2O$. All the known properties of these substances agree with the view that their constitution may be expressed by the formulæ:



The paper concludes with a discussion of the constitution of the starch molecule in the light of this new work.

DISCUSSION.

Dr. ARMSTRONG expressed the opinion that the formulæ suggested by the authors conveyed an idea of instability scarcely in accordance with the behaviour of the compounds in question. He could not help thinking that their structure was such that the ordinarily active groups were in some way shielded from attack or rendered unapproachable. Obviously, however, much more had to be learnt on such subjects. The complexity of the starch molecule was altogether remarkable when it was seen that in plants the formation of starch took place with extraordinary facility, and apparently under very simple conditions: thus starch could be detected in *Spirogyra*, originally depleted of the carbohydrate, after a very few minutes' exposure to light. It was most important to obtain further information on such a matter, as well as on the structure of the starch

molecule; he was glad, therefore, that Dr. Brown was also studying the problem from the biological side.

Mr. C. F. Cross remarked that the production of a C_5 -hydroxy-acid under the conditions of the authors' experiments would add another and comparatively simple transition from hexose to pentose derivatives, and further generalise the tendency to form C_5 -products—of which lævulinic acid and furfural are typical examples, but contrasted with the present case by complete elimination of alcoholic OH-groups. It would be important to determine whether a C_7 -derivative were actually synthesised or the one C-atom in question eliminated as a CO-derivative.

Dr. G. HARRIS MORRIS said that the authors' account of the action of diastase on the stable dextrin probably explained the contradictory statements which had been made by different observers as to the formation of dextrose from maltose under the action of the enzymes of germinated and ungerminated cereals. In working with pure maltose and the cold-water extracts of several cereals, he had been unable to obtain the slightest evidence of any such action except in the case of maize, but others, using malt-extracts and starch-conversion products, had obtained indications of the formation of dextrose. It had been assumed that this dextrose was formed by the hydrolysis of the maltose contained in the starch-conversion products, but it would now appear that it resulted from the action of the diastase on the stable dextrin, and that his conclusion that malt contained no enzyme capable of hydrolysing maltose was correct.

Mr. A. R. LING, in commenting on the observation that the dextrinic acids were well characterised substances, thought it was unfortunate that neither they nor their derivatives were crystalline. This was, perhaps, rather remarkable in the case of the acid of lowest molecular weight. He was glad to hear that the authors had convinced themselves that the so-called stable dextrin was a cupric-reducing substance. Mr. Baker and he had submitted numerous preparations of this dextrin to dialysis and fractional precipitation with aqueous alcohol for several months, and had thus obtained a final product having approximately the same optical and reducing powers as that observed by the authors.

Mr. J. F. BRIGGS asked what was the relation between the stable dextrin of R 5.5 and the dextrin which Dr. Brown formerly obtained by purification by means of mercuric cyanide: the latter had practically no reducing power.

Mr. FENTON said that he was particularly interested in the C_5 -acid described by the authors, as, in conjunction with Mr. Jackson, he hoped to prepare a similar acid from erythrose by the hydrogen cyanide reaction.

Dr. BROWN, in reply, stated that the constitution of these reducing polysaccharides can perhaps be explained in the simplest way by regarding them as complexes built up much in the same manner as the hexose residues of maltose. If the currently accepted explanation of the constitution of maltose ever requires modification, this must of course modify our views as to the exact mode of combination of the constituent groups of the polysaccharides.

The constitution of the C_5 -acid is at present occupying the attention of the authors. He agreed with Dr. Morris that these observations will go far to reconcile the conflicting statements with regard to the formation of dextrose from starch by diastase.

The non-reducing dextrins obtained in the older experiments by the mercuric cyanide method were no doubt maltodextrinic and dextrinic acids.

***16. "Propylbenzenesulphonic acids." By Gerald T. Moody, D.Sc.**

The results described in this note have been obtained in the course of an investigation on isomeric change (*Proc.*, 1888, 4, 77; 1892, 8, 90, 213, 214; 1895, 11, 48).

Propylbenzene readily sulphonates when shaken with one and a half times its own volume of ordinary sulphuric acid, and the product consists almost entirely of one propylbenzenesulphonic acid, the amide of which melts at 109—110°. This sulphonamide, on oxidation with potassium permanganate, yields 4-sulphonamidobenzoic acid (m. p. 280°), showing that it is derived from propylbenzene-4-sulphonic acid.

Propylbenzene-3-sulphonic acid and propylbenzene-2-sulphonic acid are obtained by reducing 2-bromopropylbenzene-5(?)sulphonic acid and 4-bromopropylbenzene-2-sulphonic acid respectively. Propylbenzene-3-sulphonamide melts at 57°. Propylbenzene-2-sulphonamide yields 2-sulphonamidobenzoic acid ("saccharin," m. p. 222°) on oxidation with permanganate, and melts at 128°. This melting point is identical with that of the sulphonamide of the second acid obtained in small quantity on direct sulphonation, and is much higher than either that recorded by R. Meyer, or that by Claus for the sulphonamide obtained by them respectively from the acid which they consider to be propylbenzene-2-sulphonic acid, and regard as one of the products of direct sulphonation. It is to be noted, however, that these authors do not appear to have taken the precaution of purifying the hydrocarbon employed by them, and it is extremely likely that the fuming acid used gave rise to disulphonic acid.

Propylbenzene-3-sulphonic acid and propylbenzene-2-sulphonic acid do not undergo isomeric change when heated for several hours at 150°. The stability of the latter acid, compared with that of ethylbenzene-

2-sulphonic acid, which is converted into ethylbenzene-4-sulphonic acid at the temperature of the water-bath, is remarkable, more particularly when considered in conjunction with the fact that propylbenzene-2-sulphonic acid is either not formed, or, if formed direct, is produced only in small quantity by the direct sulphonation of propylbenzene.

The author proposes next to investigate the products of sulphonation of isopropylbenzene, more particularly with reference to Claus' statement that the primary product is the parasulphonic acid, and that this is converted into ortho-derivative both on heating at the temperature of the water-bath and on allowing it to remain for 10 weeks in sulphuric acid solution.

***17. "The chemistry of the so-called nitrogen iodide."**

"Part I. The preparation and properties of nitrogen iodide."

By F. D. Chattaway and K. J. P. Orton.

Well-defined crystals of nitrogen iodide have been obtained by several new reactions. They are best produced by adding ammonia to a solution of potassium hypoiodite containing 0.02 gram-molecule per litre. The liquid, after remaining clear for about half a minute, slowly deposits glittering needles, which are copper-coloured by reflected and red by transmitted light. These crystals have a specific gravity of 3.5, are dichroic, and probably belong to the orthorhombic system.

"Part II. The action of reducing agents on nitrogen iodide."

By F. D. Chattaway and H. P. Stevens.

All ordinary reducing agents rapidly decompose nitrogen iodide being themselves oxidised, whilst hydrogen iodide and ammonia are formed. The quantity of reducing agent oxidised is found in every case to be exactly double the amount equivalent to the hydrogen iodide produced.

The results obtained by the use of sodium sulphite, sulphurous acid, arsenious oxide, antimonious oxide, stannous chloride, and hydrogen sulphide are given in the following table :

Amount of reducing agent oxidised	Na_2SO_3	H_2SO_3	As_2O_3	Sb_2O_3	SnCl_2	H_2S
Amount of hydriodic acid simultaneously produced.	HI	HI	2HI	2HI	HI	HI

The iodine contained in nitrogen iodide, therefore, behaves towards reducing agents like the chlorine contained in a hypochlorite and exerts twice its normal oxidising action.

"Part III. The composition of nitrogen iodide." By F. D. Chattaway.

Scarcely any of the numerous published analyses of nitrogen iodide agree, those of the same observer often differing widely. It is usually stated that a number of distinct compounds exist, but this statement is based entirely on these discordant results, and is unjustifiable, for in no case has the substance analysed been shown to be pure, and in no case has the reaction on which the analysis is based been thoroughly studied; two reactions, indeed, must always have occurred, one of which has been overlooked. A method of analysis has now been investigated, and the conditions necessary for a single reaction to take place determined. By means of this method, specimens prepared by every reaction known to yield nitrogen iodide have been analysed, weighed quantities of the dry substance being employed in all important cases.

It is thus proved that only one compound exists, and that this has a composition represented by the formula $N_2H_3I_3$. The molecular weight and the manner in which the atoms are linked together remain to be settled by further investigation.

"Part IV. The action of light on nitrogen iodide." By F. D. Chattaway and K. J. P. Orton.

Nitrogen iodide suspended in ammonia is decomposed both by sunlight and by artificial light, forming nitrogen and hydrogen iodide, the latter being neutralised by the ammonia, $N_2H_3I_3 = N_2 + 3HI$. At the same time, a very small quantity of the compound is hydrolysed, ammonia and ammonium hypoiodite being formed, $N_2H_3I_3 + 3H_2O = 2NH_3 + 3HOI$; $2NH_3 + 3HOI + NH_3 = 3NH_4OI$. The ammonium hypoiodite, being somewhat unstable, slowly changes into ammonium iodide and ammonium iodate, $3NH_4OI = 2NH_4I + NH_4IO_3$.

Similar actions take place when nitrogen iodide suspended in water is exposed to light, and further, the hypoiodous acid and a portion of the hydrogen iodide interact, with the result that nitrogen is evolved, and iodine, hydrogen iodide, and ammonium iodide are formed. Powdered iodine, when placed in ammonia and exposed to light, is partially converted into nitrogen iodide, which then reacts normally.

"Part V. The action of alkaline hydrates, of water, and of hydrogen peroxide on nitrogen iodide." By F. D. Chattaway and K. J. P. Orton.

Solutions of alkaline hydrates rapidly decompose nitrogen iodide, two reactions simultaneously occurring even when light is completely excluded.

The chief reaction is one of hydrolysis, ammonia and an alkaline

hypoiodite being produced. These hypoiodites, however, are unstable, and more or less rapidly change into iodides and iodates. The equations representing the action of potassium hydroxide, for example, are $\text{N}_2\text{H}_3\text{I}_3 + 3\text{KOH} = 2\text{NH}_3 + 3\text{KOI} = 2\text{NH}_3 + 2\text{KI} + \text{KIO}_3$. At the same time, a portion of the nitrogen iodide always breaks down exactly as under the influence of light (preceding abstract), yielding nitrogen and hydrogen iodide, which combines with the base forming the iodide. Solutions of ammonia or hydroxides of the alkaline earth metals act similarly.

Water causes an analogous decomposition, but in this case the hypoiodous acid formed in the hydrolysis decomposes the hydrogen iodide produced, liberating iodine. The action of water on nitrogen iodide is rendered more rapid by the presence of basic oxides, and of salts, such as iodides and carbonates, which can combine or react with the hypoiodous and hydriodic acids formed.

Hydrogen peroxide dissolved in a solution of potassium hydrate rapidly decomposes nitrogen iodide, ammonia, potassium iodide, and a trace of potassium iodate being produced, whilst oxygen mixed with a little nitrogen is evolved. The nitrogen iodide first reacts with the potash as if it alone were present, being hydrolysed to ammonia and potassium hypoiodite, but at the same time breaking down partially into nitrogen and hydrogen iodide. A very small quantity of the hypoiodite is transformed into iodide and iodate, but the greater part reacts with the hydrogen peroxide, liberating oxygen and being converted into iodide thus, $\text{KOI} + \text{H}_2\text{O}_2 = \text{KI} + \text{O}_2 + \text{H}_2\text{O}$. If a solution of hydrogen peroxide alone be added to nitrogen iodide, the water hydrolyses the compound and a similar action ensues, whilst iodine is set free by a further action of hydrogen peroxide on the hydrogen iodide remaining uncombined.

"Part VI. The action of acids on nitrogen iodide." By F. D. Chattaway and H. P. Stevens.

Dilute acids, when added to nitrogen iodide suspended in water, first induce hydrolysis of the compound, hypoiodous acid is liberated together with ammonia, which combines with the acid added, $\text{N}_2\text{H}_3\text{I}_3 + \text{acid} + 3\text{H}_2\text{O} = (2\text{NH}_3 + \text{acid}) + 3\text{HOI}$. The further action depends on the nature of the acid used. If acids be employed such as sulphuric, phosphoric, boric, or acetic, on which hypoiodous acid has no effect, a rapid change into hydrogen iodide and iodic acid occurs, the former being immediately oxidised by a portion of the latter and iodine liberated, $15\text{HOI} = 10\text{HI} + 5\text{HIO}_3 = 6\text{I}_2 + 6\text{H}_2\text{O} + 3\text{HIO}_3$. If, however, the acid used reacts with hypoiodous acid, decomposition occurs, the nature of the final products depending on the acid employed. With hydriodic acid, for example, iodine is liberated,

one half coming from the nitrogen iodide and one half from the acid, $\text{HOI} + \text{HI} = \text{I}_2 + \text{H}_2\text{O}$; with hydrochloric acid, iodine monochloride is produced, $\text{HOI} + \text{HCl} = \text{ICl} + \text{H}_2\text{O}$; whilst with hydrocyanic acid, cyanogen iodide is formed, $\text{HOI} + \text{HNC} = \text{INC} + \text{H}_2\text{O}$.

In addition to this main action, it is found that when any acid except hydriodic or hydrocyanic acid is added to nitrogen iodide, light being excluded, a variable amount, depending on the strength of the acid, &c., decomposes exactly as it does under the influence of light yielding nitrogen and hydrogen iodide; this hydrogen iodide then reacts with some of the hypiodous acid formed in the hydrolysis, liberating iodine.

“Part VII. Theory of the formation and reactions of nitrogen iodide.” By F. D. Chattaway and K. J. P. Orton.

In the formation of nitrogen iodide from iodine and aqueous ammonia, the iodine is first converted into equivalent quantities of ammonium iodide and ammonium hypoiodite, $\text{I}_2 + 2\text{NH}_4\text{OH} = \text{NH}_4\text{I} + \text{NH}_4\text{OI} + \text{H}_2\text{O}$; the greater part of the latter is then transformed into nitrogen iodide, which separates as a solid, $3\text{NH}_4\text{OI} = \text{N}_2\text{H}_3\text{I}_3 + \text{NH}_4\text{OH} + 2\text{H}_2\text{O}$, but a small portion always remains unchanged. With iodine monochloride, similar actions occur, ammonium chloride and hypoiodite being, however, the first products, $\text{ICl} + 2\text{NH}_4\text{OH} = \text{NH}_4\text{Cl} + \text{NH}_4\text{OI} + \text{H}_2\text{O}$. If a solution of sodium or potassium hypoiodite be treated with a solution of ammonia, a partial conversion into the ammonium salt precedes the deposition of nitrogen iodide, $\text{KOI} + \text{NH}_4\text{OH} = \text{NH}_4\text{OI} + \text{KOH}$. Solutions of ammonia kept in contact with nitrogen iodide are found to contain ammonium hypoiodite, the concentration increasing with the concentration of the ammonia and with the temperature. Nitrogen iodide is therefore formed from ammonium hypoiodite by a reversible action. This is found to be in accordance with the law of mass action if the concentration of the electrolytically dissociated ammonium hydroxide, NH_4OH , and not the total concentration of the ammonia, NH_3 , be considered.

The experimental evidence so far seems to point to the conclusion that nitrogen iodide bears to ammonium hypoiodite a relation similar to that which the amide bears to the ammonium salt of an acid. The constitution of the compound, however, is still doubtful. The simplest explanation of its chemical behaviour is found in formulæ such as NH_3NI_3 or $\text{NH}_2\text{I}\cdot\text{NHI}_2$, which represent each iodine atom as monovalent and directly connected with nitrogen. It is certain that neither iodine nor hydrogen iodide is present in loose molecular combination such as occurs in periodides or acid iodides.

DISCUSSION.

Dr. ARMSTRONG pointed out that, from an indexer's point of view, it was most important not to multiply papers unduly, and expressed the opinion that the four papers submitted by Messrs. Chattaway and Orton should be entered under the one simple title, "Nitrogen Iodide"; only two entries would then be required, in place of eight, in the authors' index.

In view of Dr. Chattaway's explanation that the error in the analyses communicated in his previous paper was due to exposure to light, it was worth noting, perhaps, that chemists were not sufficiently careful in excluding light: for years past he had been in the habit of brominating benzenoid hydrocarbons in the photographic dark room, with the result that products were obtained which were entirely free from the irritating odour of benzyl derivatives, and might be taken into a drawing-room without hesitation.

Dr. SCOTT referred to the much larger yield obtained when the iodine employed was dissolved in a solution of potassium iodide, and asked whether the substance so prepared was free from potassium compounds, and, bearing in mind Bunsen's formula, NH_3, NI_3 , for nitrogen iodide, whether it was not probable that some, or even the whole, of the NH_3 might be replaced by compounds such as KI , giving rise to substances such as KI, NI_3 . He also pointed out that none of the reactions described by the authors accounted for the large quantity of iodine set free when nitrogen iodide was treated with water at a temperature of $50-60^\circ$, a process employed by Stas for the preparation of pure iodine in large quantity and with perfect safety.

The PRESIDENT remarked that Guyard had suggested the employment of nitrogen iodide as an actinometer, so that the decomposition in light had been observed already. This decomposition was interesting, as it led to the inference that the iodide was an endothermic substance.

Dr. CHATTAWAY, in reply, said that a full reference to Guyard's work was given in the paper. The authors were of opinion that they had settled finally the composition of nitrogen iodide, because every analysis made subsequent to the recognition of the causes of error confirmed it. The whole behaviour of the substance was in complete accord with this composition, and every reaction could be interpreted quantitatively.

The authors' results explained completely Stas' process for the purification of iodine. When nitrogen iodide is decomposed by water, two reactions had been shown to occur simultaneously and to an approximately equal extent: a part hydrolysed forming hypoiodous acid and ammonia, a part decomposed into hydrogen iodide and

nitrogen, and the hydrogen iodide and hypiodous acid interacted liberating 90—95 per cent. of the total iodine. Slight explosions, however, were always liable to occur, and the process consequently was dangerous. No evidence had been obtained of the existence of potassium compounds such as those suggested by Dr. Scott.

18. "An isomeride of amarine." By H. Lloyd Snape, D.Sc., Ph.D., and Arthur Brooke, Ph.D.

From the distillation products, and also from the mother liquors obtained by the action of ammonium cyanide upon benzaldehyde, the authors have isolated a new base isomeric with amarine and melting at 198°. It forms salts with 1 equivalent of acids, forms a silver derivative containing 1 atomic proportion of the metal, and by distillation yields lophine.

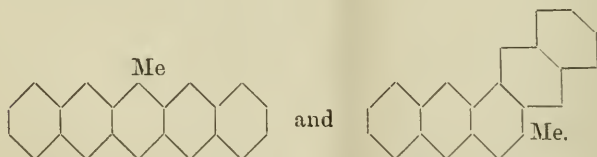
19. "The action of chlorosulphonic acid on paraffins and other hydrocarbons." By Sydney Young, D.Sc., F.R.S.

In a paper by Dr. F. E. Francis and the author (*Trans.*, 1898, 73, 932) it was shown that fuming nitric acid, at the temperature of a water-bath, acts far less energetically on normal paraffins than on iso-paraffins, methyl derivatives of the polymethylenes or aromatic hydrocarbons, and that, generally, the action is more rapid on hydrocarbons which contain a CH-group than on others.

Similar results have now been obtained with chlorosulphonic acid at the ordinary temperature, and it is shown that this reagent may be used for removing small quantities of isoparaffins and methyl derivatives of the polymethylenes from the normal paraffins separated from petroleum by fractional distillation.

20. "Derivatives of dibenzylmesitylene." By W. H. Mills and Thomas H. Easterfield.

With the object of synthesising hydrocarbons of the types



the authors have studied the benzylation of mesitylene. Dibenzylmesitylene has been described by Louise (*Ann. Chim. Phys.*, 1885, [vi], 6, 191), but its isolation is difficult under the conditions em-

ployed by him. A good yield of the compound is obtained, however, by the interaction of benzoyl chloride with mesitylene at low temperatures in presence of much aluminium chloride. It is readily reduced by zinc dust and alcoholic potash, forming dihydroxydibenzylmesitylene, $C_6HMe_3(CHPh \cdot OH)_2$, a thick oil boiling at $326-330^\circ$ at 50 mm. pressure.

Dibenzylmesitylene is obtained from the secondary alcohol by prolonged reduction with zinc dust and alcoholic potash or, more conveniently, by boiling the diketone with hydriodic acid and phosphorus. Dibenzylmesitylene is sparingly soluble in cold, easily in hot alcohol, from which it crystallises in well-defined prisms. It melts at 89° and boils at 280° under a pressure of 30 mm. Its vapour density agrees with that required for the formula $C_{23}H_{24}$. This dibenzylmesitylene differs from that described by Louise (*loc. cit.*), which melted at 131° and was sparingly soluble in hot alcohol. It is not improbable that the latter is a tribenzylmesitylene, and, as analysis alone cannot settle this point, Louise's experiments are being repeated.

When dibenzoylmesitylene is oxidised in sealed tubes with dilute nitric acid at 140° , it is almost completely converted into two isomeric *dibenzoylulvic acids*; a small quantity of *dibenzoylmesitylenic acid* is formed at the same time. The latter may be precipitated from a solution of the mixed sodium salts and sodium acetate by dilute acetic acid, and the ulvic acids from the mother liquor by hydrochloric acid. On treatment with methylic alcohol and hydrogen chloride, the crude dibenzoylulvic acids yield two isomeric methylic salts. One of these is crystalline, melts at 248° , and is sparingly soluble in alcohol; the other is oily and easily soluble. On hydrolysis, the crystalline ethereal salt yields an acid melting at 262° ; the isomeric acid from the oily salt melts at 210° . The acid of higher melting point is the more easily etherified.

The mixture of dibenzoylulvic acids is oxidised by alkaline permanganate to a *dibenzoyltrimesic acid*, which crystallises from dilute hydrochloric acid in minute rosettes melting at 245° . Its salts, with the exception of the silver, copper, lead, and ferric compounds, are easily soluble.

The action of condensing agents on these compounds is being investigated.

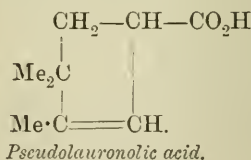
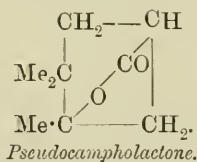
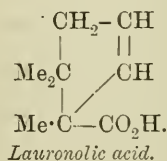
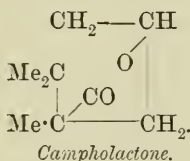
21. "On pseudocampholactone and pseudolaunonic acid." By Frederick H. Lees and W. H. Perkin, jun.

In a previous communication (*Proc.*, 1898, 14, 111), the authors showed that, when camphoric anhydride is treated in chloroform solution with aluminium chloride at ordinary temperature, there is formed,

besides isolauronolic acid, a new lactone, $C_9H_{14}O_2$, isomeric with campholactone and named pseudocampholactone. On hydrolysing this with baryta, a syrupy acid, $C_9H_{16}O_3$, was obtained; this eventually solidified, and has been found to consist of two isomeric acids, $C_9H_{16}O_3$, melting respectively at 109° and 152° .

Pseudocampholactone readily interacts with phosphorus pentabromide, and on pouring the product into methylic alcohol, *methylic bromodihydro- ψ -lauronolate*, $C_8H_{14}Br \cdot CO_2Me$, is obtained; this boils at 160 — 165° at 35 mm., and when digested with diethylaniline yields *methylic- ψ -lauronolate*, which boils at 212 — 213° at 751 mm. pressure.

ψ -Lauronolic acid, $C_8H_{13} \cdot CO_2H$, obtained by hydrolysing its methylic salt, is a colourless oil boiling at 147 — 149° at 20 mm.; it is slightly laevorotatory and is an unsaturated acid, as its solution in sodium carbonate instantly reduces permanganate. On digestion with 33 per cent. sulphuric acid, it is converted into pseudocampholactone. This new acid is of special interest, because it is isomeric with lauronolic, isolauronolic, campholytic, and allocampholytic acids, and the authors consider it probable that the relationship between campholactone and lauronolic acid and pseudocampholactone and pseudolauronolic acid may be represented by the formulæ



Isolauronolic acid is not obtained when a solution of camphoric anhydride in chloroform is left in contact with aluminium chloride for several days, but in its place two new acids are formed: a crystalline saturated acid, $C_9H_{16}O_2$, melting at 76 — 77° , and a liquid unsaturated acid. These acids, as well as ψ -lauronolic acid, are being submitted to careful investigation, the results of which the authors hope soon to be able to communicate to the Society.

22. "Nitrocamphor as an example of dynamic isomerism." By T. Martin Lowry, B.Sc.

As has been pointed out in a previous communication (*Proc.*, 1898, 14, 152), the rotatory power of both nitrocamphor and π -bromonitrocamphor varies, not only when different solvents are used, but also with time, and this may be regarded as proof that the normal and pseudo-forms of these substances are isodynamic, the change of structure being attended with a change of rotatory power in the freshly-prepared solutions. The change of rotatory power of nitrocamphor has been studied in fifteen different solvents; it usually extends over a period of a few hours or days, but at higher temperatures, or in presence of a trace of piperidine or of sodium ethylate, takes place almost instantaneously; on the other hand, a solution in chloroform can often be kept in a labile state during several days, which is perhaps an indication that the change is due to the presence of some third substance. Equilibrium is reached in the case of both nitrocamphor and π -bromonitrocamphor when about 6 per cent. of the substance in solution is in the pseudo-form.

The author advances the opinion that the changes of rotatory power which take place in freshly-prepared solutions of many of the sugars are also due to the occurrence of isodynamic change, and not to the formation of hydrates, as has usually been assumed. In the case of glucose and of lactose, both isodynamic forms appear to have been isolated in an anhydrous state; when dissolved in water they pass to a condition of equilibrium in exactly the same manner as has been found to be the case with the isodynamic forms of π -bromonitrocamphor.

The bearing of the observations made with nitrocamphor on the general problem of dynamic isomerism is discussed in the concluding sections of the paper. The author hopes to extend this method of investigation to cyanocamphor and isonitrosocamphor, and to other optically active substances which may conceivably give rise to dynamic isomerides.

23. "Position-isomerism and optical activity; the methylic and ethylic salts of benzoyl- and of ortho-, meta-, and para-toluylic acid." By Percy Frankland, F.R.S., and Frederick Malcolm Wharton.

In continuation of their work on the influence of position-isomerism on optical activity, the authors have prepared and examined the following compounds. The rotation of each compound was determined at temperatures ranging from 20—137°. The results may be summarised as follows.

ethylic malate.

$$d \quad 20^{\circ}/4^{\circ} = 1.2301 \quad [\alpha]_D^{20^{\circ}} = -6.84^{\circ}$$

Methylic benzoylmalate.

$$d \quad 21^{\circ}/4^{\circ} = 1.2121 \quad [\alpha]_D^{21^{\circ}} = -5.62^{\circ}$$

$$d \quad 99^{\circ}/4^{\circ} = 1.1395 \quad [\alpha]_D^{99^{\circ}} = -11.56^{\circ}$$

$$d137.5^{\circ}/4^{\circ} = 1.1037 \quad [\alpha]_D^{137.5^{\circ}} = -13.64^{\circ}$$

Methylic orthotoluylmalate.

$$d \quad 23^{\circ}/4^{\circ} = 1.1909 \quad [\alpha]_D = -8.94^{\circ}$$

$$d \quad 98^{\circ}/4^{\circ} = 1.1181 \quad [\alpha]_D^{98^{\circ}} = -12.40^{\circ}$$

$$d \quad 135^{\circ}/4^{\circ} = 1.0822 \quad [\alpha]_D^{135^{\circ}} = -14.09^{\circ}$$

Methylic metatoluylmalate.

$$d \quad 20^{\circ}/4^{\circ} = 1.1925 \quad [\alpha]_D^{20^{\circ}} = -6.34^{\circ}$$

$$d \quad 99^{\circ}/4^{\circ} = 1.1127 \quad [\alpha]_D^{99^{\circ}} = -11.73^{\circ}$$

$$d \quad 136^{\circ}/4^{\circ} = 1.0753 \quad [\alpha]_D^{136^{\circ}} = -13.49^{\circ}$$

Methylic paratoluylmalate.

$$d \quad 18.5^{\circ}/4^{\circ} = 1.1957 \quad [\alpha]_D^{18.5^{\circ}} = -3.14^{\circ}$$

$$d \quad 99^{\circ}/4^{\circ} = 1.1088 \quad [\alpha]_D^{99^{\circ}} = -8.33^{\circ}$$

$$d \quad 136^{\circ}/4^{\circ} = 1.0688 \quad [\alpha]_D^{136^{\circ}} = -10.14^{\circ}$$

Ethylic malate.

$$d \quad 20^{\circ}/4^{\circ} = 1.1340 \quad [\alpha]_D^{20^{\circ}} = -10.44^{\circ}$$

Ethylic benzoylmalate.

$$d \quad 21^{\circ}/4^{\circ} = 1.1561 \quad [\alpha]_D^{21^{\circ}} = -3.87^{\circ}$$

$$d \quad 98^{\circ}/4^{\circ} = 1.0759 \quad [\alpha]_D^{98^{\circ}} = -9.84^{\circ}$$

$$d \quad 137^{\circ}/4^{\circ} = 1.0349 \quad [\alpha]_D^{137^{\circ}} = -12.08^{\circ}$$

Ethylic orthotoluylmalate.

$$d \quad 21^{\circ}/4^{\circ} = 1.1391 \quad [\alpha]_D^{21^{\circ}} = -6.25^{\circ}$$

$$d \quad 100^{\circ}/4^{\circ} = 1.0714 \quad [\alpha]_D^{100^{\circ}} = -10.38^{\circ}$$

$$d \quad 136^{\circ}/4^{\circ} = 1.0405 \quad [\alpha]_D^{136^{\circ}} = -12.01^{\circ}$$

Ethylic metatoluylmalate.

$$d \quad 21^{\circ}/4^{\circ} = 1.1371 \quad [\alpha]_D^{21^{\circ}} = -4.67^{\circ}$$

$$d \quad 99.5^{\circ}/4^{\circ} = 1.0603 \quad [\alpha]_D^{99.5^{\circ}} = -9.93^{\circ}$$

$$d137.5^{\circ}/4^{\circ} = 1.0229 \quad [\alpha]_D^{137.5^{\circ}} = -11.66^{\circ}$$

Ethylic paratoluylmalate.

$$d \quad 20^{\circ}/4^{\circ} = 1.1382 \quad [\alpha]_D^{20^{\circ}} = -0.22^{\circ}$$

$$d \quad 99^{\circ}/4^{\circ} = 1.0513 \quad [\alpha]_D^{99^{\circ}} = -5.55^{\circ}$$

$$d \quad 136^{\circ}/4^{\circ} = 1.0106 \quad [\alpha]_D^{136^{\circ}} = -7.31^{\circ}$$

Thus the lævorotation of ethylic malate is diminished by the introduction of all the acidyl groups in question. The lævorotation of methylic malate is also depressed by the introduction of the benzoyl, meta- and para-toluyll groups, but raised by that of the orthotoluyll group. At 20° , the depressing, or dextrorotatory, influence of the several groups follows in the order, para-toluyll > benzoyll > meta-toluyll > orthotoluyll, both in the case of the methylic and ethylic compounds. At a high temperature (136°), on the other hand, the sequence of the dextrorotatory influences of these groups is paratoluyll > metatoluyll > benzoyll > orthotoluyll in the case of methylic malate, and paratoluyll > metatoluyll > orthotoluyll or benzoyll (practically identical) in the case of ethylic malate. In all cases, therefore, the dextrorotatory influence of the acidyl groups in question is more pronounced on the ethylic than on the methylic compound.

24. "Some regularities in the rotatory power of homologous series of optically active compounds." By Percy Frankland, F.R.S.

The author endeavours to explain the results obtained in the previous paper (Percy Frankland and Wharton) by adducing evidence that methylic and ethylic malates both exist as associated molecules, and that methylic is more associated than ethylic malate. It is suggested that the lower lævorotation of methylic as compared with

that of ethylic malate, is due to the greater degree of association of the former, and that, in the unassociated state, the laevorotation of the methylic salt would be the greater. The acidyl-malates are probably much less, if not entirely, unassociated, hence the invariably greater laevorotation of the methylic acidyl-malate as compared with that of the corresponding ethylic derivative. The author reviews a large number of other homologous series of optically active compounds, and investigates the degree of association of each term with the aid of Traube's method of calculating molecular volume. From this investigation, it would appear that the striking phenomenon of a maximum rotation occurring within an homologous series may probably be accounted for, in some cases, by the greater degree of association occurring in the initial terms, this association leading to the rotatory power actually observed being less than that possessed by the unassociated substance. In such cases, when a substitution is effected which does away with association, the maximum rotation within the series also disappears. Thus the malates exhibit a maximum rotation at the propylic term, whilst in the substituted malates the maximum disappears. In other cases, the existence of a well-defined maximum rotation within an homologous series would not appear to admit of explanation in this manner. Such maxima occur in all well-authenticated cases at about the butylic term of the homologous series, and the author suggests that this may be due to stereochemical causes, as the occurrence of some irregularity in the rotation might be anticipated at the point where a growing chain attached to the asymmetric carbon atom attains such a magnitude that the chain has doubled on itself, that is, when it contains about 5 carbon atoms. It is suggested that the same stereochemical cause may affect other physical properties, and that the greater tendency to association of the initial terms of an homologous series may be dependent on space conditions.

25. "On brasilin and hæmatoxylin." By A. W. Gilbody and W. H. Perkin, jun.

During the last three years, the authors have been investigating these important natural colouring matters, and now give a short abstract of the results obtained, in order that they may reserve the further study of the various decomposition products which they have prepared for the first time.

Trimethylbrasilin, $\text{OH} \cdot \text{C}_{16}\text{H}_{10}\text{O}(\text{OMe})_3$, when oxidised under certain conditions with chromic acid, yields *trimethylbrasilone*, $\text{OH} \cdot \text{C}_{16}\text{H}_8\text{O}_2(\text{OMe})_3$, which crystallises in straw-coloured needles, melts at 191° , and at a somewhat higher temperature loses $1\text{H}_2\text{O}$, forming *dehydrotrimethylbrasilone*, $\text{OH} \cdot \text{C}_{16}\text{H}_6\text{O}(\text{OMe})_3$. This crys-

tallises in colourless needles, melts at 198° , and when treated with acetic anhydride is converted into an *acetyl* compound $\text{OAc} \cdot \text{C}_{16}\text{H}_6\text{O}(\text{OMe})_3$, which melts at 176° , and is probably identical with the substance which Herzig (*Monats.*, 1895, 16, 913) obtained by oxidising acetyltrimethylbrasilin.

Nitric acid oxidises trimethylbrasilone, forming nitroparamethoxy-salicylic acid (m. p. 232°) and a substance represented probably by the formula $\text{C}_{11}\text{H}_8\text{O}_5(\text{OMe})_2$; the latter crystallises in yellow needles, yields an acetyl compound, reacts with phenylhydrazine and para-bromophenylhydrazine, and is characterised by forming an intense purple solution in dilute alkalis. If this purple solution is gently warmed, decomposition sets in, with the production of paramethoxy-salicylic acid (m. p. 157°) and two neutral substances, which melt at 118° and 206° , and which, on analysis, give numbers agreeing with those required for the formulæ $\text{C}_{11}\text{H}_{14}\text{O}_6$ and $\text{C}_{12}\text{H}_{14}\text{O}_6$ respectively.

From the mother liquors obtained during the preparation of trimethylbrasilone, the following substances have been isolated in small quantities. (a) A substance crystallising in colourless needles and melting at 183° . This has not yet been analysed. (b) A substance crystallising in colourless crystals, melting at 210° , and giving with ferric chloride an intense violet coloration; the analysis gave numbers agreeing with those required for the formula $\text{C}_9\text{H}_{10}\text{O}_5$. (c) A substance melting at 155° , which crystallises from water in colourless needles, and appears to be a lactone of the formula $\text{C}_{15}\text{H}_{16}\text{O}_6$. This lactone, on oxidation with permanganate, yields a dibasic acid, $\text{C}_{10}\text{H}_{10}\text{O}_3(\text{CO}_2\text{H})_2$, which melts at 200 – 203° with decomposition, due to the formation of the anhydride. When this dibasic acid is heated with hydrochloric acid at 160° , it is decomposed with elimination of carbon dioxide, and on extracting the solution with ether, beautiful, colourless prisms are obtained, which melt at 104° , and consist of pure catechol; it thus appears probable that, in addition to the resorcinol ring, brasilin contains that of catechol.

When trimethylbrasilin is oxidised with permanganate, it yields an acid melting at 129.5° , which apparently has the constitution $\text{C}_{10}\text{H}_8\text{O}_3(\text{OMe})(\text{CO}_2\text{H})$, and which, on fusion with potash, gives an oil which shows all the characteristic reactions of resorcinol. This acid, on oxidation with sodium hypobromite, is converted into an acid represented probably by the formula $\text{C}_{10}\text{H}_{10}\text{O}_9$, and this, on further oxidation with permanganate, gives an acid, $\text{C}_8\text{H}_8\text{O}_6$, which melts at about 225° with decomposition.

When *tetramethylhæmatoxylin*, $\text{OH} \cdot \text{C}_{16}\text{H}_9\text{O}(\text{OMe})_4$, is oxidised with chromic acid, it yields *tetramethylhæmatoxylone*, $\text{OH} \cdot \text{C}_{16}\text{H}_7\text{O}_2(\text{OMe})_4$, which melts at about 170° with decomposition. When heated with acetic anhydride, it yields *acetyldehydrotetramethylhæmatoxylone*,

$\text{OAc} \cdot \text{C}_{16}\text{H}_5\text{O}(\text{OMe})_4$, which crystallises in colourless needles, melts at 194° , and is probably identical with a compound melting at $191\text{--}192^\circ$, which Herzig (*loc. cit.*) obtained by oxidising acetyltetramethylhæmatoxylin.

When oxidised with nitric acid, tetramethylhæmatoxylone behaves in the same way as trimethylbrasilone, yielding a substance which crystallises in yellow needles, and dissolves in alkalis with a purple colour. This substance is being investigated, as also are several substances which have been obtained from the mother liquors obtained during the preparation of tetramethylhæmatoxylone. One of the latter compounds crystallises from water in colourless needles, melts at 214° , and on analysis gives numbers agreeing with those required for the formula $\text{C}_9\text{H}_{10}\text{O}_3(\text{CO}_2\text{H})_2$.

The authors hope, by the examination of all these new substances, to obtain results which will enable them to assign formulæ to brasilin and hæmatoxylin, and they are continuing the investigation with the aid of Mr. H. Hibbert, B.Sc., who has already afforded much assistance in examining tetramethylhæmatoxylone.

ADDITIONS TO THE LIBRARY.

I. *Donations.*

Carnot, Adolphe. *Traite d'Analyse des substances minerales.* Tome premier, methodes generales d'analyse qualitative et quantitative. Pp. 992. Paris 1898. From the Author.

Deventer, C. M. van. *Physical Chemistry for Beginners.* Translated by R. A. Lehfeldt. Pp. xvi + 146. London 1898.

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Duffet, H. *Recueil de Données Numeriques publié par la Société Francaise de Physique.* Premier fascicule. Longueurs d'onde. Indices des Gaz et des Liquides. Pp. ix + 415. Paris 1898.

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Kingzett, C. T., and Homfray, D. *A Pocket Dictionary of Hygiene.* Pp. 104. London 1898.

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Salazar, A. E. *Kalkulos sobre las Kanerias de Agua.* Kon diagramas l tablas orijinales. Pp. xiv + 246. Santiago de Chile 1898.

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II. *Purchase.*

Effront, Jean. *Les Enzymes et leurs applications.* Pp. 370. Paris 1899.

Loew, Oscar. *Die chemische Energie der lebenden Zellen.* Pp. xi+175. München 1899.

— *Ein natürliches System der Gift-Wirkungen.* Pp. viii+136. München 1893.

Mitscherlich, Eilhard. *Ueber das Benzin und die Verbindungen* (1834). Herausgegeben von J. Wislicenus. Pp. 39. Leipzig 1898. (Ostwald's Klassiker der exakten Wissenschaften Nr. 98.)

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Baker, R. T. *On two new species of Eucalyptus.* (From the *Proc. Linnean Society, N.S.W.*, 1898.)

Mallet, J. W. *On the claims of Davyum to recognition as a Chemical Element.* (From *Amer. Chem. Journ.*, 1898.)

Mingaye, J. C. H. *The Occurrence of Phosphatic Deposits in the Jenolan Caves, N.S.W.*

— *Notes and Analyses of some N.S.W. Phosphatic Minerals and Phosphatic Deposits.* (From the *A. A. A. Sc.*, 1898.)

Raoult, F. M. *Über Präzisionskryoskopie sowie einige Anwendungen derselben auf wässrige Lösungen.* (From the *Zeit. für Physik. Chem.*, 27, 1898.)

Richards, T. W., and Lewis, G. N. *Some Electrochemical and Thermochemical Relations of Zinc and Cadmium Amalgams.* (From *Proc. Amer. Acad.*, 1898.)

Smith, H. G. *On the Pinenes of the Oils of the genus Eucalyptus.* Part I. (R.S.N.S.W., 1898.)

NOTICE TO AUTHORS.

As the *Proceedings* go to press on the Monday after each ordinary Meeting of the Society, the announcement of papers for the next Meeting cannot be made in this publication unless the papers are in the hands of the Secretaries by noon on that day.

At the next meeting, on Thursday, February 16th, 1899, there will be a ballot for the election of Fellows, and the following paper will be communicated by the author:—

“The absorption spectrum and constitution of cyanuric acid.” By Professor W. N. Hartley, F.R.S.

CERTIFICATES OF CANDIDATES FOR ELECTION AT THE NEXT BALLOT.

N.B.—The names of those who sign from “General Knowledge” are printed in *italics*.

The following Candidates will be balloted for on Thursday, February 16th, 1899.

Allworthy, Samuel William,

The Manor House, Antrim Road, Belfast.

Medical profession, M.A., M.D., B.S., Trinity College, Dublin.
Diploma in State Medicine and Scholarship in Experimental Science.
Prizeman in Chemistry, &c.

A. Wynter Blyth.

Robert Barklie.

Hugh Woods.

E. S. Cameron.

Jos. F. Burnett.

A. H. McConnell.

Chas. R. C. Tichborne.

T. Maxwell.

Blackshaw, John Frank,

Holly Bank, Marton, Chelford, Cheshire.

Lecturer in Dairying and Assistant to the Professor of Agriculture, Glasgow and West of Scotland Technical College. Diploma in Agriculture, University College of North Wales. Special Diploma in advanced Agricultural Chemistry, University College of North Wales. National Diploma in Dairying, Royal Agricultural Society of England and Highland Agricultural Society of Scotland. Royal Agricultural Society of England Senior Examination, First Class. Highland and Agricultural Society of Scotland, do., First Class.

James J. Dobbie.

Edmund J. Mills.

Fred Marsden.

A. Humboldt Sexton.

G. G. Henderson.

Thomas S. Goodwin.

Blofeld, Stuart, B.A. (Lond.), B.Sc. (Lond.),

4, Camden Gardens, West Kensington Park, W.

Assistant Master in Science and Mathematics. Bachelor of Science of London University (one of the selected subjects being Chemistry). Science Master 7 years (in Chemistry especially) at (1) Teignmouth

Grammar School; and (2), Linton House School, Holland Park Avenue, W. Pupils have gained distinctions in Chemistry in University Local Examinations, and First Classes in S. K. Science and Art Examinations.

William Briggs.

S. Barlet.

J. Woodward.

J. H. Robbins.

Edwd. Jones.

C. H. Burge.

Bolam, Robert Alfred,

31, Oxford Street, Newcastle-on-Tyne.

Doctor in Medicine. Joint Lecturer in Physiological Chemistry, University of Durham College of Medicine, Newcastle-on-Tyne.

P. Phillips Bedson.

W. D. Halliburton.

F. C. Garrett.

Saville Shaw.

S. Hoare Collins.

Bowles, Bertram H.,

53, Dunsmure Road, Stamford Hill, London.

Manufacturing Chemist. Student for 3 years (Chemical Department) Technical College, Finsbury. Demonstrator's Assistant, Technical College, Finsbury. Experimental Chemist, Dartford Print and Dye Works. Works' Chemist at Shoreham Portland Cement Works. Works' Chemist, W. J. Bush & Co., Ltd., Manufacturing Chemists, Hackney.

R. Meldola.

Thomas H. Pope.

F. Southerden.

R. J. Friswell.

W. H. Barlow.

Geo. W. MacDonald.

Branscombe, William Harcourt,

Verona, Eastbourne.

Mining Engineer and Metallurgist. Graduate of Cambridge University (Sidney-Sussex College) in Applied Science. Passed in Assaying and Metallurgy (Part I.), Royal College of Science.

W. C. Roberts-Austen.

Alfred Stansfield.

Henry C. Jenkins.

Ernest A. Smith.

F. H. Neville.

Carpenter, Henry Cort Harold,

109, Banbury Road, Oxford.

Research Fellow in Chemistry in the Owens College, Manchester. Late Science Postmaster of Merton College, Oxford (1893—1896). B.A., first class in Final Honour School of Natural Science (Chemistry), Oxford. Ph.D. (Summa cum laude), University of

Leipsic (Saxony) (1896—1898). Dissertation: "Über eine Synthese des Tetraphenylcyclopentans," *Annalen*, 302, 223—236.

John Watts.

V. H. Veley.

W. H. Perkin, jun.

J. E. Marsh.

H. B. Dixon.

W. Esson.

Cheater, Thomas John,

6, Boutflower Road, Wandsworth Common, S.W.

Analyst in the Government Laboratory. Student at Inland Revenue Laboratory and South Kensington (Royal College of Science), 1884—1885. Analyst in Government Laboratory since 1885. B.Sc. (London).

T. E. Thorpe.

Edwd. Jones.

C. H. Burge.

J. H. Robbins.

E. Grant Hooper.

Geo. Stubbs.

Cope, Frank,

30, Leeds Road, Dewsbury.

Aniline Dye and Chemical Manufacturer. Engaged in the manufacture of dyes and drugs. Joint author with Mr. A. G. Perkin, F.R.S.E., on "Derivatives of Anthraquinone, Part III," and "The Constituents of *Artocarpus integrifolia*, Part I," *Chemical Society's Journal*.

J. J. Hummel.

Herbert Ingle.

A. G. Perkin.

Walter M. Gardner.

J. B. Cohen.

Arthur Smithells.

Cozens, Thomas James,

The Grammar School, Middleton-in-Teesdale, Co. Durham.

Headmaster, the Grammar School, Middleton-in-Teesdale, part Examination for Licentiate Diploma (Honours Botany), College of Preceptors. Advanced Certificates, Science and Art Department, Agriculture, Hygiene and Botany, and Practical Chemistry. Certificates from Durham College of Science, Chemistry Practical and Theoretical, Botany Practical and Theoretical. Teacher of above subjects past 4 years.

H. D. Berridge.

P. Phillips Bedson.

Alex. F. Hogg.

F. O. Solomon.

F. C. Garrett.

Epps, James Washington,

95, Upper Tulse Hill, S.W.

Chemist in Chemical Manufactory. As a student spent 2 years at University and King's Colleges, London, and 2 years with Dr. Muter;

since then and at present engaged as a Chemist in the Analytical Laboratory and Works of Messrs. Allison of Hull.

John M. Thomson.	Herbert Jackson.
William Ramsay.	Morris W. Travers.
Patrick H. Kirkaldy.	John Muter.
A. H. M. Muter.	

Estcourt, Harry Estcourt,

Hayesleigh, Old Trafford, Manchester.

Assistant Analyst, City Analyst's Laboratory, 20, Albert Square, Manchester. I have studied on the Science side at the Manchester Grammar School and attended classes at the Municipal Technical School. In the year 1890, I became a pupil in the Laboratory of the City Analyst of Manchester, and since then have had the opportunity of gaining a very varied experience in the analysis of all kinds of Food and Drugs, and commercial products. In 1895, I was Junior Assistant, with charge of pupils. I at present hold the position of Senior Assistant, and have control of the Laboratory in the absence of my uncle, Mr. Charles Estcourt.

C. Estcourt.	Francis Jones.
J. Carter Bell.	R. L. Taylor.
William Thomson.	<i>Jas. Grant.</i>

Fairweather, Ernest Barratt,

King's College Hospital, Lincoln's Inn Fields.

Head Pharmacist and Teacher of Practical Pharmacy in King's College Hospital. Studied Theoretical and Practical Chemistry and Physics under the late Mr. J. Woodland, F.C.S., and Mr. T. A. Ellwood, F.I.C. Is desirous of obtaining the Publications of the Society and consulting the Library.

John M. Thomson.	T. A. Ellwood.
Herbert Jackson.	Patrick H. Kirkaldy.
C. G. Moor.	<i>W. D. Halliburton.</i>

Fry, George Cecil,

1, Edinburgh Terrace, Newbury, Berks.

Science Teacher. Studied Chemistry in Yorkshire College, 1891—1896. B.Sc. (Vict.), Honours in Chemistry. Associate of the Institute of Chemistry. Science Master in Dronfield Grammar School, 1896—1897; in Newbury Grammar School, 1897.

Arthur Smithells.	A. E. Tutton.
Herbert Ingle.	C. F. Baker.
Julius B. Cohen.	<i>J. J. Hummel.</i>
Henry R. Procter.	<i>A. G. Perkin.</i>

Frye, Colin Charlwood,

Burwood, Woodville Road, Ealing.

Three years studying Chemistry at University College, London. Two years Demonstrator in Chemistry at the Pharmaceutical Society. Part author of "Note on the Action of Bromine on Benzene," *J. C. S.* Author of note on "Distilling Dilute Solutions of Potassium Permanganate with Sulphuric Acid in Vacuo," *Chem. News*.

J. Norman Collie.

Arthur Lapworth.

William Ramsay.

Morris W. Travers.

Thomas Tickle.

Gabriel, Edmund Vivian,

Bengal United Service Club, Calcutta.

Her Majesty's Indian Civil Service (Bengal). First Class Natural Sciences Tripos, Part I, and Second Class Natural Sciences Tripos, Part II, Cambridge University. Science Scholar of Emmanuel College, 1893—1898. Studying the subject of Agricultural Chemistry in India.

S. Ruhemann.

R. S. Morrell.

M. M. Pattison Muir.

J. Murray Crofts.

Francis Jones.

R. H. Adie.

T. B. Wood.

W. T. N. Spivey.

Golding, John,

1, Balmoral Road, Nottingham.

Agricultural Chemist, *i.e.*, Lecturer, Demonstrator, and Analyst to the Agricultural Department of the University College, Nottingham, under the County Councils of Notts, Derby, Leicester, and Lincoln (Lindsey Division). Chemical training in the Laboratories of the Pharmaceutical Society of Great Britain. Practical experience as Analyst and Lecturer: four years in R.A.S.E. Laboratory under Dr. J. A. Voelcker, one year under Essex County Council, and four years in present position. Original work, &c., published: *Journ. Soc. Chem. Ind.*, 16, 514, and 17, 125; *Transactions Nottingham Naturalists' Soc.*, 1896, 1897; *Midland Dairy Inst. Annual Reports*, &c.; and Board of Agriculture Report on "Distribution of Grants," &c. Work in hand, on Nitrogen Assimilation by Bacteria.

J. Augustus Voelcker.

F. Stanley Kipping.

M. J. R. Dunstan.

J. J. Sudborough.

R. M. Caven.

Hall, Samuel Godfrey,

19, Aberdeen Park, Highbury, N.

Soap Manufacturer. Studied Chemistry and Physics at University College, London, under Professors W. Ramsay and Carey Foster

during years 1893—1895 ; since then continued work in Laboratory of East London Soap Works, Bow, E.

William Ramsay.

John Spiller.

G. Carey Foster.

David Howard.

R. Meldola.

Thomas Tyrer.

Harper, Henry Winston, M.D.,

Austin, Texas, U.S.N.A.

Associate Professor of Chemistry, in charge of the School of Chemistry, and Director of the Chemical Laboratory of the (State) University of Texas. Studied at the Philadelphia College of Pharmacy, and afterwards at the University of Virginia (Medical Department) Formerly Chemist and Metallurgist to Colorado and Refugio Mining and Smelting Co. and Imogene Mining Co. in Mexico. Afterwards practioner of medicine, and for four years past in charge of School of Chemistry in the University of Texas. Author of published papers on *Rhus aromatica*, on solanin, on a deposit of magnesium sulphate in Brown Co., Texas, on some Texas waters, on certain toxicological cases, &c.

J. W. Mallet.

F. P. Venable.

F. P. Dunnington.

Jas. Lewis Howe.

W. L. Dudley.

Hartley, Harold Brewer,

Romney Lodge, New Park Road, Clapham Park, S.W.

Brackenbury Scholar in Natural Science, Balliol College, Oxford. Student of Chemistry.

John Conroy.

William E. Moss.

D. H. Nagel.

H. Brereton Baker.

A. Vernon Harcourt.

Hedley, George Ward,

2, St. Luke's Villas, Cheltenham.

Assistant Master, Cheltenham College. Open Exhibitioner in Natural Science, Merton College, Oxford, 1890—1894. 1st Class in the final School of Natural Science (Chemistry), 1894. M.A., 1897.

Francis Jones.

W. W. Fisher.

H. Brereton Baker.

William Esson.

John Watts.

J. E. Marsh.

Hembrough, James,

159, Hotwell Road, Clifton, Bristol,

Senior Lecturer in Chemistry, Leeds Southern Higher Grade School, Leeds. Ten years' scientific training, chiefly in Chemistry.

Honours in Practical Inorganic and Organic Chemistry, (S. and A. Dept.). Associate in Chemistry of the Royal College of Science, (Lond., 1894), Associate of the Institute of Chemistry (1897).

W. Palmer Wynne.

Ernest H. Cook.

S. Parrish.

T. E. Thorpe.

James Leicester.

Henry, Thomas Anderson,

37, Chelsea Gardens, S.W.

Assistant Chemist, Salters' Research Fellow in the Laboratories of the Imperial Institute. Student in the Pharmaceutical Society's School 1893—1894. Student in the Pharmaceutical Society's Research Laboratory, 1894—1896. Author, with Professor Dunstan, of the following papers: "A Chemical Investigation of the Constituents of Indian and American Podophyllum," *J.C.S.*, April, 1898; "The Volatile Constituents of *Goupia tomentosa*," *J.C.S.*, 1898. "Oxycannabin," *Proc., C.S.*, No. 189, 1898.

Wyndham R. Dunstan.

C. M. Luxmoore.

H. A. D. Jowett.

R. L. Jenks.

Ernest Goulding.

Hewitt, Tom Lacey,

Beech Field, St. John's, Higher Broughton, Manchester.

Student in Chemistry. Desirous of a Fellowship for Society's Publications, &c. Hold S. and A. certificates in Organic and Inorganic Chemistry, Advanced. For 8 months pupil under Mr. G. H. Hurst, F.C.S. For 6 months Junior Assistant Chemist at the Clayton Aniline Co. For 8 months Analyst to Mr. A. Hailwood, Milk Contractor, Manchester. Since October, 1897, Student at the Owens College. Member of the Society of Chemical Industry.

George H. Hurst.

David Watson.

H. Grimshaw.

Jas. R. Appleyard.

Thos. Southern, jun.

J. Lewkowitsch.

Knight, Harold Octavius,

Westfield Villa, Barton-on-Humber.

Barytes and Whiting Manufacturer, &c. Student in the Chemical Laboratories of the Owens College, 1889—1891. Science Master, Wellington College, Salop, 1891—1896. Manufacturing Chemist since 1896.

Ernest Scott.

H. B. Dixon.

Percy J. Winsor.

G. H. Bailey.

W. H. Perkin, jun.

Linstead, Edward Flatman,

35, Hayter Road, Brixton Hill, S.W.

Analytical Chemist. Chemist on the staff of Messrs. Burroughs, Wellcome and Co., London and Dartford.

Frederick B. Power.

Arthur R. Ling.

H. A. D. Jowett.

B. E. R. Newlands.

William J. Pope.

Lucas, Alfred,

Maison Hussein Pasha, Cairo, Egypt.

Analytical Chemist. Student Royal College of Science, South Kensington, London, 1891—1892. Analyst in the Government Laboratory, London, since 1892, now holding a temporary appointment under the Egyptian Government as Chemist to the Salt Department.

T. E. Thorpe.

C. Proctor.

E. Grant Hooper.

Edwd. Jones.

J. Woodward.

Geo. Stubbs.

Luxton, Thomas,

4, Cavendish Square, Margaret Street, Hull.

Teacher of Chemistry, Municipal Technical School, Hull. B.Sc. and B.A. (London). Have been engaged in teaching Chemistry and Physics entirely during the last 10 years. Formerly Science Master at Queen's College, Taunton, and at the Central Higher Grade School, Hull, and now head of Chemical Department, Technical School, Hull. Have at various times done Laboratory work in most branches of Chemistry and Chemical Physics.

John J. Pilley.

Harry Thompson.

Frederick William de Velling.

Fred. E. Johnson.

Alex. F. Hogg.

H. Irving Foster.

Mackenzie, Thomas,

8, Gardner Street, Glasgow.

Pharmaceutical Chemist. Teacher of Chemistry from March, 1895, in the Glasgow and West of Scotland School of Chemistry and Pharmacy. Major Examination of Pharmaceutical Society of Great Britain.

W. Watson Will.

F. F. de Morgan.

William Duncan.

Peter MacEwan.

W. L. Howie.

R. R. Tatlock.

W. Chas. Sayers.

Martin, Samuel Montagu,

Westwood, Princetown Road, Bangor, Co. Down.

Chemist, Analyst, and Chief of Laboratory of the firm of John

Clarke and Co., Limited, Manufacturing Chemists, Belfast. Licentiate of the Pharmaceutical Society of Ireland. Author of paper, "Pepsin and Essence of Rennett Chemically compared." Late Assistant Teacher of Chemistry, Belfast School of Applied Chemistry.

Bernard H. Paul.

H. N. B. Richardson.

D. Lloyd Howard.

Lewis Ough.

Thomas Tyrer.

R. E. S. Richardson.

Maudsley, Joshua,

Merchiston Castle, Edinburgh.

Science Master. Hastings Exhibitioner in Chemistry and Physics, Queen's College, Oxford, 1892. First Class Honours in the Final School of Chemistry, Oxford, 1896. Science Master, Merchiston School, Edinburgh.

W. W. Fisher.

V. H. Veley.

John Watts.

J. E. Marsh.

H. L. Bowman.

McCracken, James,

580, Govan Road, Govan.

Manager and Secretary. Several years Analytical Chemist in Laboratory of Messrs. Wm. Beardmore and Co. and Wear Steel Co. For the past 7 years with the Carbon Cement Co., Limited, at present as Manager and Secretary. Technical Certificates in Honours Chemistry, Metallurgy, Mathematics, Theoretical Mechanics, Electricity and Magnetism, Iron and Steel Manufacture.

Edw. C. Stanford.

Thomas S. Goodwin.

A. Humboldt Sexton.

H. W. Dickinson.

G. G. Henderson.

Mirrlees, Arthur,

Redlands, Kelvinside, Glasgow.

Chemist to Sugar Factory, Sandwich Islands. B.A. (Chemistry) Cambridge.

J. Henry Gilbert.

R. Haliburton Adie.

N. H. J. Miller.

T. B. Wood.

John Bennet Lawes.

R. S. Morrell.

Mohr, Bernhard,

69A, Parliament Hill, Hampstead, N.W.

Consulting Chemist. Ph.D. (Heidelberg).

Ludwig Mond.

J. Wilson Swan.

Hugo Müller.

W Kellner.

H. Sprengel.

Molson, John Cavendish, L.R.C.P., London.

42, Sackville Road, Hove, Brighton.

Physician and Surgeon. Fellow of the British Gynæcological Society, Fellow of the Royal Geographical Society, Member of the British Medical Association, formerly Student of Chemistry at the City and Guilds of London Institute, &c., &c.

Raphael Meldola.

Henry E. Armstrong.

Julian L. Baker.

B. E. R. Newlands.

A. M. Simpson.

Arthur R. Ling.

J. H. Coste.

Nance, John Trengove,

District Bank, Newcastle, Staff.

B.A., Oxford. Honours in Chemistry in Natural Science School, Oxford.

John Conroy.

William E. Moss.

D. H. Nagel.

R. Hornby.

A. Vernon Harcourt.

Nicholls, William Walter Scott,

230, Brockley Road, Brockley, S.E.

Assistant to Analysts in Government Laboratory. Student at Royal College of Science, Session 1891—1892. Demonstrator in Chemical Laboratory, Birkbeck Institution, Session 1887—1888, 1888—1889. Seven years' employment in Government Laboratory.

T. E. Thorpe.

E. Grant Hooper.

H. J. Helm.

J. Woodward.

C. H. Burge.

Edwd. Jones.

Northall-Laurie, Dudley,

56A, Pall Mall, S.W.

Student of the Institute of Chemistry of Great Britain and Ireland. Studying at King's College. Head of Cheltenham School in Chemistry, 1895. Student under Mr. Edgar Jackson, F.I.C., Analyst, 1896.

John M. Thomson.

J. H. Hichens.

Herbert Jackson.

William Crookes.

Patrick H. Kirkaldy.

J. Augustus Voelcker.

O'Sullivan, John,

742, Nicola Street, Vancouver City, B.C.

Chief Assayer and Chemist to the B.C. Agency, Limited, of London, England; 26 years' experience in practical assaying and Chemistry in Messrs. Vivian & Sons' Hafod Laboratory, Swansea. Obtained the following Certificates from Science and Art Department (London, England). 1st Class, E. and Lab. grant in Inorganic Chemistry 1876;

1st Class E. Metallurgy and 2nd Class Advanced Chemistry, 1st Class Advanced Theoretical and 2nd Advanced Practical, 1878.

W. Terrill.

Clarence A. Seyler.

Christopher James.

T. Rhymer Marshall.

Sydney W. Harris.

Pizey, James Henry,

9, Lady Somerset Road, Highgate Road, N.W.

Analytical Chemist. Studied one year in the Chemical Laboratories at University College, London; and three years in the Royal College of Science, of which half the time was devoted to Chemistry. I am now working in Laboratory of Mr. Blount, F.I.C., at Westminster.

William A. Tilden.

M. O. Forster.

W. Palmer Wynne.

Bertram Blount.

Chapman Jones.

W. Harry Stanger.

Price, Robert Coleman,

Blacksburg, Virginia, U.S.N.A.

Professor of Chemistry in the Virginia Polytechnic Institute. Studied for three years at the University of Virginia, and for one year at Wiesbaden under the late Prof. Fresenius. For four years Assayist to the State Board of Agriculture of Virginia. For eight years Professor of Chemistry in the Virginia (State) Polytechnic Institute. Author of a paper on the composition and mineralogical relations of the mineral Tscheffkinite.

J. W. Mallet.

F. P. Venables.

F. P. Dunnington.

Jas. Lewis Howe.

Wm. L. Dudley.

Pyne, Horace Seymour,

Castletown, Isle of Man.

Lecturer in Science (Chemistry and Physics) at King William's College, Isle of Man. For 13 years Lecturer on Chemistry at King William's College, Isle of Man. Chemical Depolariser in conjunction with improved form of Primary Battery, Patent No. 15355, August 12th, 1893. Treatment of kelp with perchloride of iron for extraction of iodine.

Fred. H. Bowman.

Francis Henry Tate.

T. A. Reid.

Edward Davies.

Hy. Fairrie.

Roberts, James, jun.,

43, Great Western Road, Glasgow.

Chemist (Assistant to Professor of Chemistry). Commenced the study of Chemistry in the Glasgow and West of Scotland Technical College in 1893, proceeding from there to the Chemical Laboratory at

the University. Became an unofficial Assistant in Spring of 1896, and was appointed an official Assistant in May, 1897. Has engaged in research in the chemistry of coal, and is part author of several papers on the subject.

John Ferguson.

Thomas Gray.

W. R. Lang.

James Robson.

G. G. Henderson.

Matthew A. Parker.

J. T. Bottomley.

Skirrow, Frederick William,

Graystongill, Bentham, Lancaster.

Student, B.Sc. (Vict.), First Class Honours in Chemistry, and Leblanc Medal for Applied Chemistry, Research Student in the Yorkshire College.

Arthur Smithells.

J. B. Cohen.

H. R. Procter.

Herbert Ingle.

John McCrae.

Soddy, Frederick,

Merton College, Oxford.

Student. Have been a Student of Chemistry since 1893, and obtained a First Class in the Final School in Chemistry, Oxford, 1898.

W. W. Fisher.

John Conroy.

William Ramsay.

D. H. Nagel.

John Watts.

Stevenson, Arnold,

4, Porchester Gardens, London, W.

Student, B.A. Cambridge, 1898. Educated at Winchester College, Clare College, Cambridge, 1893-1898. First Class Natural Science Tripos, Part I., 1897. Second Class Natural Science Tripos, Part II., 1898.

H. J. H. Fenton.

W. J. Sell.

John M. Thomson.

W. T. N. Spivey.

Thomas H. Easterfield.

T. B. Wood.

Szarvasy, Dr. Charles Emerique,

19, Weymouth Street, Portland Place, W.

Research Chemist. Doctor of Philosophy. I have been four years student and four years as Lecturer at the University of Budapesth, one year worker at the University of Berlin, and at present worker at the Davy-Faraday Research Laboratory of the Royal Institution. Author of ten papers.

Alexander Scott.

James H. Millar.

William Arbuckle.

W. P. Bloxam.

Meyer Wilderman.

Walter, Louis Heathcote,

83, Holland Park Avenue, W.

Electrical Engineer and Engineering Chemist. B.A. Trin. Coll., Cambridge, Nat. Sci. Tripos, 1897. At present time assistant to Hiram S. Maxim, Esq., in his private laboratory.

M. M. Pattison Muir.

Thomas Girtin.

R. S. Morrell.

S. Ruhemann.

A. Hutchinson.

White, Arthur Lee,

29, Huron Road, Upper Tooting, S.W.

Student. B.Sc., (Lond.); Associate of the Institute of Chemistry; Associate of the Yorkshire College. Has worked four years at the Yorkshire College and two and a-half years at the Royal College of Science, London, where he is at present studying.

William A. Tilden.

J. J. Hummel.

Arthur Smithells.

W. Palmer Wynne.

Chapman Jones.

White, Henry Fox,

Warnham, Woodland Road, Clifton, Bristol.

Pharmaceutical Chemist. After Matriculation at London University in June, 1891, I was for three years a Student at Univ. College, Bristol, studying Chemistry under Dr. Young, F.R.S. I then went to London, and for six months studied advanced chemistry (theoretical and analytical) under W. Watson Will, Esq., F.C.S., at the Metropolitan Coll. of Pharmacy. At the end of that course I passed the Major Examination of the Pharmaceutical Society. I have at present an engagement with Messrs. Giles, Schacht and Co. of Clifton as Manufacturing and Analytical Chemist.

Sydney Young.

F. Filmer De Morgan.

W. Watson Will.

W. Chas. Sayers.

Arthur Richardson.

Peter MacEwan.

W. A. Shenstone.

Williams, William Arthur,

75, High Street, Wapping, London, E.

Chemist. Junior Demonstrator, City and Guilds Technical College, Finsbury, and Research Assistant to Professor R. Meldola, F.R.S., F.C.S., F.I.C.

R. Meldola.

W. J. Dibdin.

Arthur J. Chapman.

Robt. G. Grimwood.

R. Grimwood.

J. H. Coste.

Wormell, Thomas Wilson,

184, Burrage Road, Plumstead, London, S.E.

Science Master and Lecturer at Woolwich Polytechnic. B.Sc. (Lond.); Final taken in Chemistry, Physics, and Mathematics. Honours 1st Class (S. Kensington) Practical Inorganic Chemistry. Teacher of Chemistry and Physics under Manchester School Board for two years, &c.

R. Lloyd Whiteley.

Frank Clowes.

J. Bernard Coleman.

J. J. Sudborough.

R. M. Caven.

PROCEEDINGS
OF THE
CHEMICAL SOCIETY.
EDITED BY THE SECRETARIES.

Vol. 15.

No. 204.

February 16th, 1899. Professor Dewar, F.R.S., President, in the Chair.

Mr. W. S. Crouch was formally admitted a Fellow of the Society.

Certificates were read for the first time in favour of Messrs. George Smith Bratby, Oak Field, Hale, Bowdon, Cheshire; John Elias Hughes, Birchville, Wrexham; Lauder William Jones, University of Chicago, Chicago, Ill., U.S.A.; Frederick William Pittuck, 19, Stratford Grove, Newcastle-on-Tyne; Harold McLean Read, 127, Warwick Road, Earl's Court, S.W.; Harry Alexander Thiersch, 8, Clifton Gardens, W.; Arthur Luvian Wade, 28, West Kensington Gardens, W.; Charles Walker, Scott Chambers, Pitt Street, Sydney, N.S.W.; Fred Sheasby Watson, Springside, Disley, Cheshire.

A ballot for the election of Fellows was held, and the following subsequently declared duly elected:—

Samuel William Allworthy, M.A.; John Frank Blackshaw; Stuart Blofeld, B.A., B.Sc.; Robert Alfred Bolam, M.D.; Bertram H. Bowles; William H. Branscombe, B.A.; H. Cort H. Carpenter, B.A., Ph.D.; Thomas John Cheater; Frank Cope; Thomas James Cozens; James Washington Epps; Harry Estcourt Estcourt; Ernest Barratt Fairweather; George Cecil Fry, B.Sc.; Colin Charlwood Frye; Edmund Vivian Gabriel, M.A.; John Golding; Samuel Godfrey Hall; Henry Winston Harper, M.D.; Harold Brewer Hartley, B.A.; George Ward Hedley, M.A.; James Hembrough; Thomas Anderson Henry; Harold Octavius Knight; Edward Flatman Linstead; Alfred Lucas; Thomas Luxton, B.A., B.Sc.; Thomas Mackenzie; Samuel Montagu Martin; Joshua Maudsley, B.A.; James McCracken; Arthur Mirrlees, B.A.; Bernhard Mohr, Ph.D.; John Cavendish Molson; John Trengove

Nance, B.A.; William Walter Scott Nicholls; Dudley Northall-Laurie; John O'Sullivan; James Henry Pizey; Robert Coleman Price; Horace Seymour Pyne; James Roberts, Jun.; Frederick William Skirrow, B.Sc.; Frederick Soddy, B.A.; Arnold Stevenson, B.A.; Charles Emerique Szarvasy, Ph.D.; Louis Heathcote Walter, B.A.; Arthur Lee White, B.Sc.; Henry Fox White; William Arthur Williams; Thomas Wilson Wormell, B.Sc.

The PRESIDENT announced that Mr. C. E. Groves, F.R.S., had resigned the Editorship of the Society's Journal, and that Dr. W. P. Wynne, F.R.S., had been appointed to succeed him. The Council had recorded their sense of Mr. Groves' services to the Society in a vote of thanks, a copy of which would be engrossed on vellum and presented to him at the Anniversary Meeting.

It was announced that the following changes in the Officers and Council were proposed by the Council:—

As *President*.—Professor T. E. Thorpe, Ph.D., D.Sc., LL.D., F.R.S., *vice* Professor James Dewar, M.A., LL.D., F.R.S.

As *Vice-Presidents*.—Mr. C. E. Groves, F.R.S., and Professor Thomas Purdie, Ph.D., F.R.S., *vice* Professor F. R. Japp, M.A., LL.D., F.R.S., and Professor W. A. Tilden, D.Sc., F.R.S.

As *Hon. Secretary*.—Dr. Alexander Scott, F.R.S., *vice* Dr. W. P. Wynne, F.R.S.

As *Hon. Treasurer*.—Professor W. A. Tilden, D.Sc., F.R.S., *vice* Professor T. E. Thorpe, LL.D., F.R.S.

As *Ordinary Members of Council*.—Mr. H. Brereton Baker, M.A., Professor F. Clowes, D.Sc., Dr. G. T. Moody, and Professor James Walker, D.Sc., *vice* Professor Bedson, D.Sc., Mr. Hehner, Professor McLeod, F.R.S., and Dr. Scott, F.R.S.

Dr. H. T. Brown, F.R.S., Dr. A. W. Crossley, and Mr. R. J. Friswell, were appointed to audit the Society's accounts.

Of the following papers, those marked * were read.

***26. "On the absorption spectrum and constitution attributed to cyanuric acid." By W. N. Hartley, F.R.S.**

The spectrum of cyanuric acid was described by the author in 1882, (*Trans.*, 41, 84) as exhibiting an absorption band between wave-lengths 2747 and 2572, and the formula deduced was that of a symmetrical trihydroxybenzene in which the three CH-groups are replaced by three nitrogen atoms. The bulk of the original preparation having been carefully preserved, its absorption spectrum has been photographed again with the improvements and modifications devised by

the author in 1883 (*Phil. Trans.*, 1885, 176, 471). The results show that 2.5 grams of cyanuric acid, when dissolved in hot, distilled water, made up to 500 c.c. and placed in cells respectively 200 mm. and 100 mm. in length, exhibited nothing which could be described as an absorption band. In the first case, the warm solution cut off the spectrum sharply at about wave-length 2572, but transmitted the rays only weakly from about 3330, and in the 100 mm. cell the spectrum was cut off sharply at 2483. The spectra thus obtained are in complete harmony with the formula $(\text{H}\cdot\text{N}:\text{C}:\text{O})_3$, but not with that formerly given.

A searching examination of all the conditions and circumstances surrounding the preparation of the solutions and photographs of the original spectra shows that the possibility of any foreign substance getting into the cyanuric acid was almost precluded. But as the specimen was purchased, there might have been, perhaps, a milligram or less of some solid substance adhering accidentally to the lip of the bottle, or attached to the cork, which would be weighed out with the first quantity of crystals. There are many well-known substances, of which a milligram would suffice to produce the effect observed.

***27. "A study of the absorption spectra of isatin, carbostyryl, and their alkyl derivatives in relation to tautomerism." By W. N. Hartley, F.R.S., and James J. Dobbie, D.Sc., M.A.**

In this paper, the authors trace the relation between the curves of molecular absorption and the constitution of isatin, carbostyryl, and their alkyl derivatives. They start from the fact (*Phil. Trans.*, 1879, 170, Part I, 257) that the substitution of a methyl or ethyl group for an atom of hydrogen without other alteration in the structure of the substance, merely increases the general absorption, i.e., slightly shortens the transmitted spectrum without making any difference in the character of the absorption, and show that when the curves of molecular absorption of the substances studied are compared, a very close resemblance is seen to exist between the parent substance and one of the two isomeric derivatives.

In the carbostyryl group, the spectra of carbostyryl, methylcarbostyryl, and methyl- and ethyl-pseudocarbostyryl are compared. Carbostyryl and methylpseudocarbostyryl both show an absorption band in the same position, and the spectra of the two substances are, in other respects, almost identical, the only difference being that the general absorption is slightly increased in the case of methyl- and ethyl-pseudocarbostyryl, which is the effect usually produced when alkyl radicles are substituted for hydrogen. The spectra of methylcarbostyryl differ in a marked manner from those of carbostyryl and methyl-

pseudocarbostyryl ; the absorption band occupies a different position, is less persistent and less intense than the corresponding band of the latter, and the amount of the general absorption is less.

Isatin and its derivatives show similar relations. In the spectra of isatin there are two absorption bands. The spectra of methylpseudoisatin closely resemble those of isatin, likewise exhibiting two absorption bands, and about the same extent of general absorption. In methylisatin, there is only one strong absorption band.

The authors conclude that the very close resemblance between the curves of molecular absorption of carbostyryl and methyl- and ethylpseudocarbostyryl and between those of isatin and methylpseudoisatin, point to identity of constitution, and, inasmuch as the chemical behaviour of methylpseudocarbostyryl and methylpseudoisatin show that these compounds are lactams, the lactam constitution must also be assigned to carbostyryl and isatin. This conclusion agrees with that arrived at by Goldschmidt and Meissler (*Ber.*, 1890, 23, 253), who employed a purely chemical method in their investigations, and with the more recent results of Knorr (*Annalen*, 1896, 293, 81).

A detailed account of the various spectra is given in the paper.

DISCUSSION.

Dr. J. H. GLADSTONE said that the study of the selective absorption of the rays of light by different substances was a physical method of research which, in his opinion, had been too much neglected. It was capable, beyond doubt, of distinguishing between different compounds of an elementary substance, and, in some instances, of throwing light on their constitution. If the absorption of rays of light by a compound were always the sum of the absorption of its separate constituents, or if different compounds of the same element gave totally different spectra, this mode of analysis would be of little use : investigation showed, however, that similarity is often associated with suggestive differences. Thus, in the case of ferric salts, the extreme red ray is always transmitted with the greatest ease, whilst the blue-green and other more refrangible rays are soon absorbed ; yet the rapidity of absorption varies very much, as may be seen in the great difference in the degree of redness of such ferric salts as the nitrate and sulphocyanide. Observations such as these were much facilitated by placing the liquid in a hollow prism instead of in a cell with parallel sides, as, in this way, the gradual absorption of the various rays by different thicknesses could be seen and mapped at once. The absorption of different kinds of rays might be employed for the purpose of chemical research, each having, no doubt, its own story to tell, and fruitful results might be expected from the use, not only of the

coloured rays of the visible spectrum and of the more refrangible rays which Professor Hartley is engaged in photographing, but also of the less refrangible heat rays, and even, perhaps, of the X rays in the future.

Professor DOBBIE pointed out that the relation of such substances as isatin and its methyl derivatives to one another had long been a vexed question, and that it had not been found possible to solve it by means of chemical methods. The advantage of the spectroscopic method was that the uncertainty, due to possible shifting of the atoms in the course of a chemical reaction, did not arise. It was interesting to note that the results obtained by this method were in complete agreement with those most recently arrived at by chemical processes, in which care had been taken to eliminate, as far as possible, the sources of error inseparable from the older methods.

Dr. A. HARDEN referred to Schiff's work on the isolation of tautomeric forms of ethylic acetoacetate, and asked whether experiments had been made with the object of isolating and of examining spectroscopically the enolic form of isatin.

The PRESIDENT said that every physical method which in any way could aid in establishing the identity of a material under investigation was of the utmost importance to future workers. A substance might seem to be pure so far as evidence derived from ordinary analytical methods was concerned, and yet reveal the presence of impurity when its ultra-violet spectrum was examined. This was the case with water, the ultra-violet spectrum of which was most characteristic, and served to indicate the presence of water vapour in gases dried by the ordinary methods. He was inclined to think that some improvement might be made in the selection of the material for obtaining the ultra violet spectrum. The cadmium spectrum was open to the objection that wide gaps existed in which no lines were present, and the use of a material such as iron, which gave a spectrum of lines more evenly distributed in the ultra-violet, would seem to be preferable.

Professor HARTLEY, in reply, said that, when working with rays of high refrangibility, it had been found best to use a quartz cell in which the faces were parallel.

The use of the iron spectrum for the study of absorption spectra had attracted his attention in the past, and was referred to in the paper published in 1879; the objections to its use were that too many lines were present, and that two very strong groups existed in the more refrangible part where absorption bands were likely to occur. The best electrodes for use were those made of cadmium-tin and cadmium-lead alloys containing 15--20 per cent. of cadmium; the lines were sufficiently numerous and distinct, but not too strong,

and there was, moreover, the continuous spectrum between them forming, as it were, a background.

The investigation of tautomeric compounds was in progress, and the results would form the subject of a separate communication to the Society.

***28. "The estimation of nitrites and nitrates by means of ferrous chloride." By A. Wynter Blyth.**

The author has devised an apparatus in which nitrites and nitrates, either singly or together, can be estimated as nitric oxide by means of ferrous chloride. The essential feature of the apparatus is a mercury valve, which is made by connecting one end of a long delivery tube with the side tube of a flask, and causing the other to dip below the surface of mercury in the mercurial trough, the bend of the delivery tube being 770 mm. above this level. The air from the flask is expelled by boiling, and a special feature is made of the ease with which successive vacua can be obtained in such a flask. The author has found that nitric oxide is evolved from nitrites at once, whereas there is an appreciable interval of from one to two minutes before any nitric oxide is formed from nitrates. Nitrates yield the whole of the nitric oxide only when the flask is evacuated several times. The results obtained with the apparatus are accurate.

DISCUSSION.

Mr. J. H. COSTE said that eight years ago he had used in the laboratory of the Royal Agricultural Society of England an apparatus similar in principle to that described by the author, but of simpler construction. It was, he believed, devised by Dr. Walter Leather, and was described in Addyman's *Agricultural Analysis*. The india-rubber stopper of the evolution flask was provided with a water jacket, and fitted with a delivery tube considerably over 760 mm. in length, dipping under the surface of mercury in a tray placed at a lower level. The use of the rising tube described by the author was thus obviated. The results obtained and the ease in manipulation left little to be desired.

Mr. WYNTER BLYTH, in reply, stated that he did not claim anything new in the principle of the apparatus; it had, indeed, been applied for some time in the construction of mercury pumps. He was glad to hear that the same kind of valve was in use successfully elsewhere.

***29. "Estimation of boric acid mainly by physical processes."
By A. Wynter Blyth.**

When a methylic alcohol solution of boric acid is distilled, 78 per cent. of the acid collects in the first fifth of the distillate; a dilute aqueous solution, on the contrary, loses very little of the acid until concentration has taken place. These facts are applied to the detection of minute traces of boric acid in various substances.

It is shown that even small quantities of boric acid can be estimated by polarimetric methods. For this purpose, 3 grams of dextrotartaric acid are dissolved in methylic alcohol, and the solution of boric acid in methylic alcohol added so as to make exactly 20 c.c. at 18°. The increase of rotation is then observed. For quantities amounting to 0.05—1.03 per cent., a 5 dm. tube is required. The specific rotation, calculated on the constant amount of the tartaric acid present, is given for quantities ranging from 0.05—3 per cent.

When boric acid is boiled with a solution of sodium carbonate, carbon dioxide is evolved, in accordance with the equation $\text{Na}_2\text{CO}_3 + 4\text{H}_3\text{BO}_3 = \text{Na}_2\text{B}_4\text{O}_7 + \text{CO}_2 + 6\text{H}_2\text{O}$, the proportion being 0.177 part by weight for every part of boric acid present. After boiling and concentrating, the solution is made up to a definite volume, and the conductivity at 18° measured by Kohlrausch's method. From the reduction of the resistance, the amount of boric acid, as sodium borate, can be estimated provided the sodium carbonate solution employed is always of the same strength. A table is given of the values of K (resistance of cell divided by resistance, in ohms, of solution), and the results are plotted out as a curve. After the resistance has been determined, an aliquot part or the whole of the solution is transferred to a flask connected with the apparatus described in the preceding abstract, and the carbon dioxide estimated by treatment with an acid.

DISCUSSION.

Mr. A. C. CHAPMAN pointed out that small quantities of impurities in the boric acid would be likely to sensibly affect the accuracy of physical methods such as those suggested by the author, and asked how the whole of the boric acid could be obtained from such substances as food-products in a state of sufficient purity for the application of these methods.

Mr. WYNTER BLYTH, in reply, said that distillation with methylic alcohol gave the methyl compound in a state of sufficient purity for the purpose of estimation by the polarimetric method.

30. "The interaction of ethylic sodiomalonate and mesityl oxide. A correction." By Arthur W. Crossley.

Since the publication of a preliminary notice on the action of ethylic sodiomalonate on mesityl oxide (*Proc.*, 1898, 14, 247) Dr. Vorländer of Halle has pointed out to the author that the reaction has already been studied. The substance obtained by hydrolysis of the condensation product is dimethylhydroresorcine, $C_8H_{12}O_2$, and possesses half the molecular weight assigned to it by the author, and although having marked acid properties is not a carboxylic acid.

The author expresses his regret at not having known of Dr. Vorländer's work.

31. "On Lössner's benzoylethyloxysulphocarbamic acid, and the formation of pseudoureas." By Augustus Edward Dixon, M.D.

Benzoyl chloride interacts with a hot saturated solution of potassium thiocyanate, yielding potassium chloride and a compound, $C_{10}H_{11}NSO_2$, regarded by Lössner (*J. prakt. Chem.*, 1874, [ii], 10, 237) as benzoylethyloxysulphocarbamic acid, $COPh \cdot NEt \cdot CO \cdot SH$. Miquel (*Ann. Chim. Phys.*, 1877, [v], 11, 334), showed later that the same compound is produced from benzoylthiocarbimide and ethylic alcohol, and that consequently it is not an acid, but an 'ether,' $COPh \cdot NH \cdot CS \cdot OEt$. With caustic potash, it affords a potassium derivative, from which by interaction with ethylic iodide, the corresponding ethylic compound is obtained; the latter is decomposed by ammonia into mercaptan, together with a supposed unsymmetrical benzoylethylurea, $COPh \cdot NEt \cdot CO \cdot NH_2$.

In the present paper, it is shown that the constitution assigned to this 'urea' is not in accordance with its properties. On hydrolysis, it yields carbonic and benzoic acids, alcohol, and ammonia, but no ethylamine, from which it follows that the ethylic group is not attached to nitrogen, and the conclusion is drawn that the supposed urea of Lössner is really the ethylic salt of a benzoylated imidocarbamic acid, $COPh \cdot N : C(OEt) \cdot NH_2$. Corresponding compounds have now been obtained, which bear towards the ureas a relation similar to that subsisting between the pseudothioureas and the thiocarbamides: to maintain uniformity of nomenclature, it is proposed that such imido-derivatives of organic salts of carbamic acid should be termed pseudoureas generically.

The constitution attributed by Lössner to the ethylic derivative from which the above ethyl- ψ -*n*-benzoylurea is obtained is $COPh \cdot NEt \cdot CO \cdot SEt$; its properties, however, are inconsistent with this structure,

and the author assigns reasons for representing it by the formula $\text{COPh}\cdot\text{N}:\text{C}(\text{OEt})\cdot\text{SEt}$. If the potassium compound from which the latter is produced be similarly constituted, Miquel's formula for Lössner's benzoylethylxysulphocarbamic acid requires further modification into that of the tautomeric ethylic imidobenzoylthiocarbonate, $\text{COPh}\cdot\text{N}:\text{C}(\text{OEt})\cdot\text{SH}$.

Methyl-ψ-n-benzoylurea, $\text{COPh}\cdot\text{N}:\text{C}(\text{OMe})\cdot\text{NH}_2$, is deposited from light petroleum in fern-like masses of white, flattened crystals, melting, without decomposition, at $77-78^\circ$. When boiled with alkali, or heated with water at $150-160^\circ$ under pressure, it is hydrolysed into carbonic and benzoic acids, ammonia, and methylic alcohol; no ethylamine could be detected. Its isomeride, *ab-benzoylmethylurea*, $\text{COPh}\cdot\text{NH}\cdot\text{CO}\cdot\text{NHMe}$, is prepared by desulphurising the corresponding thiocarbamide with silver nitrate; the thiocarbamide separates from alcohol in tufts of shining needles, the urea in colourless, thick prisms; they melt at 152° and 171° respectively.

Ethyl-ψ-n-benzoylurea, $\text{COPh}\cdot\text{N}:\text{C}(\text{OEt})\cdot\text{NH}_2$, forms rhombohedral crystals melting at $74-75^\circ$ without decomposition. Its isomeride, *ab-benzoylethylurea*, is stated by Miquel to melt at 192° , or, according to Leuckart (*J. prakt. Chem.*, 1880, [ii], 21, 33), at 168° . When prepared from the thiocarbimide (m. p. $130-131^\circ$) by means either of silver nitrate or, as described by Miquel, of yellow oxide of mercury, it was found to melt at $114-115^\circ$.

Anisoilthiocarbimide, $\text{OMe}\cdot\text{C}_6\text{H}_4\cdot\text{CO}\cdot\text{NCS}$, is obtained, in solution, by heating the corresponding chloride, $\text{OMe}\cdot\text{C}_6\text{H}_4\cdot\text{COCl}$, dissolved in benzene, with lead thiocyanate. It unites with alcohol, forming *anisoilthiourethane* or *ethylic imidoanisoilthiocarbonate*, $\text{OMe}\cdot\text{C}_6\text{H}_4\cdot\text{CO}\cdot\text{N}:\text{C}(\text{SH})\cdot\text{OEt}$, which crystallises in small, white needles melting at $70-71^\circ$. The *potassium derivative* of the latter melts at about 222° (uncorr.); when boiled in alcoholic solution with ethylic iodide, and then saturated with ammonia, it yields *ethyl-ψ-n-anisoilurea*, $\text{OMe}\cdot\text{C}_6\text{H}_4\cdot\text{CO}\cdot\text{N}:\text{C}(\text{OEt})\cdot\text{NH}_2$, in white, transparent prisms melting at $69-70^\circ$.

Anisoilthiocarbimide unites spontaneously with nitrogenous bases forming thioureas and thiocarbamides; the following are described. *Anisoilthiourea*, $\text{CSN}_2\text{H}_3\cdot\text{C}_8\text{H}_7\text{O}_2$, forms rhombs and octahedra melting at $216-217^\circ$. By fusion with chloracetic acid, it yields *anisoilthydantoin* [*n-anisoilthiourantoin* (*Trans.*, 1897, 71, 638)], a pale-yellow solid, nearly insoluble in the ordinary solvents, and decomposing between 222° and 230° . *ab-Anisoilphenylthiocarbamide* crystallises from alcohol in brilliant prisms melting at 126° ; the corresponding *ortho*- and *para*-tolyl compounds melt at 126.5° and $127-128^\circ$ respectively. *ab-Anisoilmethylthiocarbamide* melts at $143-144^\circ$; the *ethylic* homologue melts at $126.5-127.5^\circ$, and yields, on desulphurisa-

tion, the symmetrical urea, $C_8H_7O_2 \cdot NH \cdot CO \cdot NHEt$, isomeric with the above ψ -compound; it melts at $146-147^\circ$. *ab-Anisoilbenzylthiocarbamide* forms colourless prisms melting at $127-128^\circ$. *n-Anisoil-v-phenylbenzylthiourea*, $C_8H_7O_2 \cdot N : C(SH) \cdot NPhBz$, from the thiocarbimide and benzylaniline, occurs in brilliant rhombic plates melting at $142-143^\circ$. It is not desulphurised by boiling with alkaline solution of lead, in which respect it differs from the other anisoil thio-compounds described.

32. "On certain isomeric tertiary benzylthioureas." By Augustus Edward Dixon, M.D.

n-Phenyl-v-methylbenzylthiourea, $NPh : C(SH) \cdot NMe \cdot CH_2Ph$, was obtained, in quantitative amount, from phenylthiocarbimide and methylbenzylamine; it formed long, brilliant, silvery prisms melting at $129-130^\circ$. Its isomerides, $NMe : C(SH) \cdot NPhBz$, and $NBz : C(SH) \cdot NMePh$, melt at 121° and 85° respectively. By desulphurisation with silver nitrate, it afforded the *urea*, $NHPh \cdot CO \cdot NMeBz$, which crystallised in thin, pearly needles melting at $134-135^\circ$.

n-Benzyl-v-methylbenzylthiourea, $NBz : C(SH) \cdot NMeBz$, prepared from benzylthiocarbimide and methylbenzylamine, occurred in vitreous needles melting at 73° . Its isomeride, *n-methyl-v-dibenzylthiourea*, $NMe : C(SH) \cdot NBz_2$, formed white, rhombic crystals melting at $110-111^\circ$.

n-Methyl-v-methylbenzylthiourea, $NMe : C(SH) \cdot NMeBz$, formed vitreous, flattened crystals melting at $87.5-83.5^\circ$. Its isomeride, *n-benzyl-v-dimethylthiourea*, $NBz : C(SH) \cdot NMe_2$, crystallised in vitreous prisms melting at $98.5-99.5^\circ$.

These thioureas are practically insoluble in water; they are unaffected by boiling with alkaline lead tartrate, but are readily desulphurised by warming with nitrate of silver. It was remarked in 1893 (*Trans.*, 63, 540) that amongst the then known phenylated isomeric tertiary thioureas, the member containing the NPh -group had the highest melting point; it is now shown that, in the methyl-phenylbenzyl series, this is also the case.

33. "Is camphene unsaturated?" By J. E. Marsh.

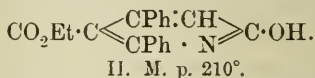
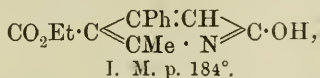
The more recent formulæ for camphor, such as that of Bredt, represent camphene, the typical hydrocarbon of the group, as an unsaturated compound with one double linking. The reactions which appear to support this view are, firstly, the conversion of camphene into camphene glycol, $C_{10}H_{16}(OH)_2$, by the action of potassium permanganate (Wagner, *Ber.*, 1890, 23, 2307), and, secondly, the production of camphene di-

bromide, $C_{10}H_{16}Br_2$, by the action of bromine on camphene (Reychler, *Ber.*, 1896, **29**, 900). These reactions would be sufficient to establish the unsaturated character of camphene if it were a matter quite free from doubt that camphene glycol and camphene dibromide are the simple additive compounds they appear at first sight to be. The so-called camphene glycol, however, appears to possess none of the properties of a true glycol; and, in particular, the fact that it readily loses water, forming a compound having all the properties of an aldehyde, seems to be inconsistent with the view that it is a glycol at all. Moreover, the action of permanganate on camphene is much slower than is usually the case with an unsaturated compound. With regard to camphene dibromide, experiments have been made by the author which lead him to believe that this compound is not formed by the direct union of bromine and camphene, but is really the product of the interaction of bromine and camphene hydrobromide. By saturating camphene dissolved in glacial acetic acid with hydrogen bromide, and then adding bromine to the product, the so-called camphene dibromide is obtained in amount equal to about 70 per cent. of the theoretical yield, whereas Reychler, by the direct action of bromine on camphene, obtained only 8 grams from 27.7 grams of camphene, which represents a yield of about 13 per cent. The chief product of the action of bromine on camphor is the substituted derivative bromocamphene, $C_{10}H_{15}Br$. In this reaction, then, it appears that bromine first replaces hydrogen in camphene, forming bromocamphene and hydrogen bromide; the hydrogen bromide is partly given off in the gaseous form, but in part also combines with the excess of camphene, forming camphene hydrobromide, which is then further acted on by bromine, giving the so-called camphene dibromide by the substitution of bromine for hydrogen. This reaction, therefore, cannot be brought forward as evidence in favour of the unsaturated character of camphene. It may be argued, perhaps, that the direct union of camphene with hydrogen bromide is in itself sufficient evidence of its unsaturated character. It does not, however, appear to be consistent with the nature of the double linking that it should resist the action of bromine and succumb to that of hydrogen bromide. Such a property is far more characteristic of the trimethylene ring, as Professor Perkin has shown, and may be characteristic also of other ring formations.

34. "Formation of α -pyrone compounds and their transformation into pyridine derivatives." By Siegfried Ruhemann.

The substances formed from α -pyrone derivatives by the addition of two molecular proportions of ammonia (*Proc.*, 1899, **15**, 6), have been transformed into pyridine compounds. The view already

expressed, that these additive products may be regarded as ammonium salts of unsaturated amino-acids, readily explains such a change. The transformation is effected by preparing from the ammonium salts the corresponding ethylic salts, which, on distillation, lose alcohol and condense to the pyridine compounds represented by the formulæ :



From the ethylic salt represented by formula I., the corresponding acid was prepared; this loses carbon dioxide at 240°, forming phenylmethylpyridone (m. p. 207—208°).

β -Diketones, like ethylic salts of β -ketonic acids, condense with ethylic phenylpropiolate under the influence of sodium ethoxide, forming α -pyrone derivatives of the general formula $\text{CPh} \begin{array}{c} \text{CH} \text{---} \text{CO} \\ \text{C}(\text{COR}) \text{:CR}' \end{array} \text{O}$, in which R and R' denote hydrocarbon radicles. Thus, from acetylacetone and from benzoylacetone, compounds have been obtained which melt respectively at 128° and 143—144°, and behave like α -pyrone derivatives with alcoholic ammonia.

ANNIVERSARY MEETING.

The Anniversary Meeting will be held on Wednesday, March 29th, at 3 o'clock in the afternoon.

NOTICE TO AUTHORS.

As the *Proceedings* go to press on the Monday after each ordinary Meeting of the Society, the announcement of papers for the next Meeting cannot be made in this publication unless the papers are in the hands of the Secretaries by noon on that day.

At the next meeting, on Thursday, March 2nd, 1899, the following papers will be communicated:—

“Bromomethylfurfuraldehyde.” By H. J. H. Fenton, M.A., and Mildred Gostling, B.Sc.

“The action of metallic thiocyanates on certain substituted carbamic and oxamic chlorides, and a new method for the production of thiobiurets.” By Augustus Edward Dixon, M.D.

“Ethylic $\beta\beta$ -dimethylpropanetetracarboxylate.” By W. Trevor Lawrence.

“The action of alkyl iodides on hydroxylamine.” By Wyndham R. Dunstan, F.R.S., and Ernest Goulding, B.Sc.

PROCEEDINGS
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EDITED BY THE SECRETARIES.

Vol. 15.

No. 205.

March 2nd, 1899. Professor Dewar, F.R.S., President, in the Chair.

Mr. John S. MacArthur was formally admitted a Fellow of the Society.

Certificates were read for the first time in favour of Messrs. Clement Harrison Baker, Athelney, Featherstone Road, King's Heath, Birmingham; Frederick James Beale, Wilderspool Brewery, Warrington; Alfred Ernest Bond, Prince's Chambers, Corporation Street, Birmingham; Charles Robert Darling, 220, Eglinton Road, Plumstead; Percy Haigh, 312, Romford Road, Forest Gate, E.; Thomas Judge, 142, Waller Road, New Cross, S.E.; William McConnell, 178, Springfield Road, Glasgow; Wilfred Walter Morris, Newtown St. Boswells, Roxburghshire, N.B.; Maurice Emile Schweich, 85, Belgrave Road, S.W.; Edward Thomas Shelbourn, 1, Chalcot Crescent, Regent's Park Road, N.W.; Richard Threlfall, 45, Frederick Road, Edgbaston, Birmingham; Ernest Albert Tyler, Warsop, Mansfield, Notts.

Of the following papers, those marked * were read.

*35. "Bromomethylfurfuraldehyde." By H. J. H. Fenton, M.A.,
and Mildred Gostling, B.Sc.

It has been shown by the authors in a previous communication (*Trans.*, 1898, 73, 556) that certain carbohydrates, when acted on by hydrogen bromide in ethereal solution, give rise to a beautiful, purple coloration. From observations made with a considerable number of typical carbohydrates, it would appear that the rapid production of

this intense colour is characteristic of ketohexoses, or substances capable of yielding them by hydrolysis. The colour-producing substance has now been isolated in a pure state, and is obtained in the form of short, golden-yellow, prismatic crystals belonging to the oblique system. It melts at 60° , decomposes somewhat explosively at a higher temperature, and is practically insoluble in cold water, but dissolves easily in most organic solvents, giving solutions which powerfully stain the skin. Its solutions give a bright orange colour with aniline acetate after some time; they powerfully reduce silver and copper solutions, react with phenylhydrazine, and when treated with an ethereal solution of hydrogen bromide, produce an intense purple coloration, which is exactly similar to, but appears even more quickly than, that obtained with ketohexoses. Analysis and molecular weight determinations show that it has the formula $C_6H_5BrO_2$, and its reactions and properties indicate that it is a bromomethyl-

furfuraldehyde,
$$\begin{array}{c} H \cdot C = C - CHO \\ | \quad | \quad \diagup \\ H \cdot C = C - CH_2Br \end{array} \quad \begin{array}{c} O \\ \diagdown \end{array}$$
 . On oxidation with silver oxide, it

yields ω -hydroxymethylpyromucic acid identical with that obtained by Hill and Jennings from the corresponding bromo-acid (*Amer. Chem. J.*, 1893, 15, 162). The whole of the bromine is precipitated by an alcoholic solution of silver nitrate, and from the solution a substance is obtained which closely resembles, but seems to be isomeric with, the hydroxymethylfurfuraldehyde of Düll and Kiermayer (*Chem. Zeit.*, 1895, 19, 206, 1003); a similar result is obtained by heating the substance with water in presence of barium carbonate. If the substance be covered with water and saturated with sulphur dioxide, it slowly dissolves, and the solution, after remaining for some hours, gives, on extraction by ether, a product which crystallises from hot water in yellow needles; these melt at 117° , and in solution give a magnificent blue colour with caustic alkalis. Analysis and molecular weight determinations indicate that this is a condensation product, and is free from bromine; its constitution is now being investigated.

***36.** "The reaction of alkyl iodides with hydroxylamine. Formation of alkylated hydroxylamines and oxamines." By Wyndham R. Dunstan, F.R.S., and Ernest Goulding, B.Sc.

As the authors have shown previously (*Proc.*, 1894, 10, 138; *Trans.*, 1896, 69, 839), methyl iodide readily reacts with hydroxylamine, forming hydriodides of hydroxylamine and the hydriodide of a trimethyl derivative. The hydrated base crystallises well and melts sharply at 96° . It is not volatile. The anhydrous base has not yet been isolated. The aqueous solution is strongly alkaline, and

does not reduce Fehling's solution. Solution of silver nitrate is only reduced on warming, or after prolonged standing. Dimethylamine and formaldehyde are produced by the action of hydriodic acid, but no methyl iodide. The same decomposition ensues when the base (or its salts) is heated either alone or with dilute sulphuric acid, $(\text{CH}_3)_3\text{NO} = \text{CH}_2\text{O} + \text{NH}(\text{CH}_3)_2$. When allowed to stand in aqueous solution in contact with zinc dust, it is reduced to trimethylamine, $(\text{CH}_3)_3\text{NO} + \text{H}_2 = (\text{CH}_3)_3\text{N} + \text{H}_2\text{O}$.

The principal salts of the base are described.

The authors conclude that this substance is not a true trimethylhydroxylamine, but a *trimethyloxammonia* or *trimethyloxamine*, $(\text{CH}_3)_3\text{N}^+\text{O}^-$.

By the reaction of methyl iodide with trimethyloxamine, the iodide of a tetramethyl derivative is produced. The free base, which is strongly alkaline, has, so far, been obtained only in aqueous solution. The salts crystallise well.

When the solution of a salt is warmed with an alkali, methyl alcohol is split off and trimethyloxamine is formed, $\text{N}(\text{CH}_3)_3\text{OCH}_3\text{OH} = \text{N}(\text{CH}_3)_3\text{O} + \text{CH}_3\text{OH}$.

When the aqueous solution of a salt is heated at 150° in a closed tube, trimethylamine and formaldehyde are produced, $\text{N}(\text{CH}_3)_3\text{OCH}_3\text{OH} = \text{N}(\text{CH}_3)_3 + \text{CH}_2\text{O} + \text{H}_2\text{O}$.

When the iodide is heated with concentrated hydriodic acid, the products are methyl iodide, dimethylamine, and formaldehyde, $\text{N}(\text{CH}_3)_3\text{OCH}_3\text{OH} + \text{HI} = \text{NH}(\text{CH}_3)_2 + \text{CH}_3\text{I} + \text{CH}_2\text{O} + \text{H}_2\text{O}$.

When reduced in aqueous solution with zinc dust, trimethylamine and methyl alcohol are formed, $\text{N}(\text{CH}_3)_3\text{OCH}_3\text{OH} + \text{H}_2 = \text{N}(\text{CH}_3)_3 + \text{CH}_3\text{OH} + \text{H}_2\text{O}$.

The base is, therefore, *trimethylmethoxyammonium hydroxide*, $(\text{CH}_3)_3\text{N}^+\text{OCH}_3^-\cdot\text{OH}$.

When ethyl iodide reacts with hydroxylamine, hydriodides of hydroxylamine are formed, together with a *diethylhydroxylamine hydriodide*. The base is an oily liquid with a curious aromatic odour, boiling, with some decomposition, between $130-134^\circ$. Its aqueous solution is strongly alkaline, and acts as a powerful reducing agent. The salts are fully described; the oxalate, $[(\text{C}_2\text{H}_5)_2\text{NOH}]_2\text{H}_2\text{C}_2\text{O}_4$, crystallises very readily and melts at $136-137^\circ$. When heated, it decomposes into ethylamine and acetaldehyde, $(\text{C}_2\text{H}_5)_2\text{NOH} = \text{C}_2\text{H}_5\text{NH}_2 + \text{C}_2\text{H}_4\text{O}$. When heated with hydriodic acid, diethylamine is formed, but no ethyl iodide. It forms an acetyl derivative. The substance is, therefore, a true β -*diethylhydroxylamine*, $\text{N}(\text{C}_2\text{H}_5)_2\text{OH}$. It is isomeric with the two diethylhydroxylamines described by Lossen ($\text{NH}(\text{EtOEt})$), but is probably identical with the substance obtained by Kissel by the action of zinc ethyl on nitroethane. The substance

now described closely resembles in its decompositions the β -dibenzylhydroxylamine studied by Behrend and Leuchs.

By the reaction of diethylhydroxylamine with ethyl iodide, the hydriodide of a triethyl derivative is obtained. The base is crystalline and non-volatile. The aqueous solution is strongly alkaline. It does not reduce Fehling's solution, but reduces silver nitrate on warming. The principal salts are fully described. In all its reactions, this base closely corresponds with trimethyloxamine. When heated, it breaks up into diethylamine and acetaldehyde; when reduced with zinc dust in aqueous solution, it furnishes triethylamine, whilst by the action of hydriodic acid it is converted into triethylamine without the formation of ethyl iodide. This substance is, therefore, *triethyloxyammonia* or *triethyloxamine*, $(C_2H_5)_3N:O$. It is not identical with the isomeride of triethylhydroxylamine which Bewad describes as resulting from the action of zinc ethyl on nitroethane.

Similarly, normal propyl iodide and secondary propyl iodide react with hydroxylamine, forming *dipropyl-* and *di-isopropylhydroxylamines*, $(C_3H_7)_2NOH$.

Hantzsch and Hilland (*Ber.*, 1898, 31, 2058) have recently described their work on this subject. They generally confirm the account given by the authors five years ago of the reaction of methyl iodide with hydroxylamine. They assert that the hydrated base (see above) is really a carbonate. The authors have repeated their experiments, and find that there is no foundation for this statement. It is evident, from the different account given by Hantzsch and Hilland of the properties of trimethyloxamine, that the material they examined contained impurity, probably hydroxylamine.

By the reaction of ethyl iodide with hydroxylamine, Hantzsch and Hilland obtained only monethylhydroxylamine hydriodide. The authors have repeated their experiments, and have been unable to isolate any such substance. They find, as stated above, that diethylhydroxylamine is the chief product of the reaction.

DISCUSSION.

Dr. HEWITT drew attention to Bamberger's recent discovery of the analogous dimethylaniline oxide by the direct oxidation of dimethylaniline by hydrogen peroxide (*Ber.*, 1899, 32, 342). The substance is destitute of reducing properties, and exhibits a peculiar transformation into a mixture of ortho- and para-nitrodimethylanilines by the action of nitrous acid. This transference of an oxygen atom from the dimethylamino- to the nitroso-group, thereby converting it into a nitro-group, may possibly be the analogue of the conversion of trimethyloxamine into a mixture of dimethylamine and formaldehyde.

Dr. FORSTER remarked that distillation under atmospheric pressure resolves the benzyl ether of camphoroxime into benzaldehyde and camphorimine, a change suggesting analogy with the conversion of trimethyloxamine into formaldehyde and dimethylamine.

***37. "Derivatives of $\alpha\alpha'$ -dibromocamphorsulphonic acid." By Arthur Lapworth.**

When ammonium α -bromocamphorsulphonate is heated with bromine and water at $110-120^\circ$, a dibromocamphorsulphonic acid is produced, identical with that obtained in small quantities by heating the salt with dilute nitric acid (*Trans.*, 1897, 71, 19; compare *Proc.*, 1898, 14, 159), and its investigation has been continued with the following results.

The ammonium, potassium, sodium, calcium, barium, zinc, cadmium, and lead salts are readily soluble in water and crystallise well; the basic lead salt is amorphous, and is practically insoluble in water. $\alpha\alpha'$ -Dibromocamphorsulphonic chloride, $C_{10}H_{13}Br_2O \cdot SO_2Cl$, is very sparingly soluble in the usual media; it crystallises in beautiful, hemihedral forms belonging to the orthorhombic system, is isomorphous with the sulphonic bromide already described (*loc. cit.*), and melts at $203-204^\circ$ with decomposition. The amide, $C_{10}H_{13}Br_2O \cdot SO_2NH_2$, forms hemihedral crystals, is very sparingly soluble in the ordinary media, and melts at about 238° with decomposition.

When $\alpha\alpha'$ -dibromocamphorsulphonic chloride is treated with piperidine in ethereal solution, a mixture of dibromocamphorsulphopiperidide, $C_{10}H_{13}Br_2O \cdot SO_2NC_5H_{10}$, and monobromocamphorsulphopiperidide, $C_{10}H_{14}BrO \cdot SO_2NC_5H_{10}$, is obtained. The former crystallises in orthorhombic plates or prisms melting at $157-158^\circ$; the latter, which may also be obtained by the action of piperidine on α -monobromocamphorsulphonic chloride, crystallises in plates melting at 152° .

When dibromocamphorsulphonic acid is heated with strong alkalis, bromine is eliminated, and the product, on treatment with phosphorus pentachloride, yields α -monobromocamphorsulphonic chloride melting at 135° , the action being exactly analogous to that of alcoholic potash or soda on $\alpha\alpha'$ -dibromocamphor.

When heated at its melting point, $\alpha\alpha'$ -dibromocamphorsulphonic bromide loses sulphur dioxide, yielding $\alpha\alpha'$ -tribromocamphor, $C_{10}H_{13}Br_3O$. This crystallises from dilute alcohol in fine needles and melts at $69-70^\circ$; it is rapidly decomposed when warmed with solutions of silver salts or with alkalis, the product with the latter being $\alpha\pi$ -dibromocamphor melting at 152° . The new tribromocamphor is also obtained by heating $\alpha\pi$ -dibromocamphor with bromine at 120°

in sealed tubes; this fact and others which have been mentioned indicate that the dibromocamphorsulphonic acid has the constitution assigned to it by the author.

38. "Ethylic $\beta\beta$ -dimethylpropanetetracarboxylate." By W. Trevor Lawrence.

Meyenburg (private communication, compare *Ber.*, 1895, 28, 785) attempted to prepare ethylic $\beta\beta$ -dimethylpropanetetracarboxylate by the condensation of ethylic isopropylenemalonate with ethylic sodiomalonate, but was unsuccessful, and, with his permission, the author has continued the work.

Ethylic $\beta\beta$ -dimethylpropanetetracarboxylate, $\text{CMe}_2[\text{CH}(\text{CO}_2\text{Et})_2]_2$, is formed in small amount in preparing ethylic isopropylenemalonate from acetone and ethylic malonate in the presence of acetic anhydride and zinc chloride. It is obtained readily by the interaction of molecular quantities of ethylic isopropylenemalonate with ethylic sodiomalonate in dry ethereal or benzene solution. The mixture is allowed to boil during 24 hours, a half molecular proportion of ethylic sodiomalonate added, and the boiling continued during a further 24 hours. On fractional distillation in a vacuum, the compound is obtained as a thick oil boiling at 218° under 14 mm. pressure. On hydrolysis with alcoholic potash, it is converted into $\beta\beta$ -dimethylpropanetricarboxylic acid, $\text{CO}_2\text{H}\cdot\text{CH}_2\cdot\text{CMe}_2\cdot\text{CH}(\text{CO}_2\text{H})_2$, melting at 172° , and with sulphuric acid into $\beta\beta$ -dimethylglutaric acid, $\text{CO}_2\text{H}\cdot\text{CH}_2\cdot\text{CMe}_2\cdot\text{CH}_2\cdot\text{CO}_2\text{H}$, melting at 101° , from which the anhydride melting at 123° was obtained.

The author is engaged with Dr. Herz in the further investigation of the properties of the substance

39. "The action of metallic thiocyanates on certain substituted carbamic and oxamic chlorides; and a new method for the production of thiobiurets." By Augustus Edward Dixon, M.D.

Acid chlorides containing the group COCl interact with metallic thiocyanates, in presence of suitable solvents, yielding the corresponding organic isothiocyanates; chlorine united with certain groups, other than carbonyl, is similarly exchangeable, but complete dechlorination is generally hard to effect. Experiments made with a view of ascertaining whether the halogen in substances generally acidic in character, or only that in direct union with a negative group could thus be substituted, pointed to the latter as the determinant condition.

By heating with mercuric thiocyanate in presence of cumene, the chlorides of disubstituted carbamic acids are converted into isothio-

cyanates of the form $\text{NR}_2 \cdot \text{CO} \cdot \text{NCS}$; these substances are related to the thiobiurets and to thioallophanic acid in the same way as ordinary thiocarbimides to thiocarbamides and thiocarbamic acid respectively. They unite spontaneously with nitrogenous bases, affording substituted thiobiurets, and with benzylic alcohol, forming the corresponding substituted thioallophanates, $\text{NR}_2 \cdot \text{CO} \cdot \text{NH} \cdot \text{CS} \cdot \text{OBz}$.

These thiobiurets may be regarded as thiocarbamides containing the carbamyl or $\text{NR}_2 \cdot \text{CO}$ -group; if so, the rule formulated by the author with respect to desulphurisation of the thiocarbamides by alkaline lead tartrate (*Trans.*, 1893, 63, 318) holds good, the carbamyl group here playing the same part as an alkylic or allylic radicle. Thus, the thiobiurets, $\text{NR}_2 \cdot \text{CO} \cdot \text{NH} \cdot \text{CS} \cdot \text{NHX}$, can be desulphurised when X is an aromatic radicle, but not when it is aliphatic. Their behaviour as carbamylthiocarbamides (or thioureas) is further instanced by the production of thiohydantoin-like [derivatives on treatment with chloracetic acid; the latter compounds are related to the biurets in the same way as the thiohydantoins to the thiocarbamides, and, in like manner, yield thioglycollic acid on hydrolysis.

The isothiocyanates could not be freed from the accompanying cumene by distillation either with steam or under diminished pressure; their solutions were used in preparing the following derivatives.

(1) *Diphenylcarbamylisothiocyanate*, $\text{NPh}_2 \cdot \text{CO} \cdot \text{NCS}$, with aniline gives *acc-triphenylthiobiuret*, $\text{NPh}_2 \cdot \text{CO} \cdot \text{NH} \cdot \text{CS} \cdot \text{NHPh}$, crystallising in white needles which melt at $163\text{--}163.5^\circ$ and yield phenylthiocarbimide when heated with acetic anhydride. *a-Orthotolyl-c-diphenylthiobiuret*, $\text{NPh}_2 \cdot \text{CO} \cdot \text{NH} \cdot \text{CS} \cdot \text{NHTo}$, from orthotoluidine, occurs in fine, white needles melting at $163.5\text{--}164^\circ$. When desulphurised by silver nitrate, it affords the corresponding *biuret*, $\text{NPh}_2 \cdot \text{CO} \cdot \text{NH} \cdot \text{CO} \cdot \text{NHTo}$, melting at $132\text{--}133^\circ$. *a-Paratolyl-c-diphenylthiobiuret* melts at $172\text{--}172.5^\circ$, and resembles generally the ortho-derivative. *a-Methyl-c-diphenylthiobiuret* melts at $170\text{--}171^\circ$; the *ethyl*ic homologue at $137\text{--}138^\circ$, and the corresponding *benzylic* derivative at $167\text{--}168^\circ$. *c-Diphenylthiobiuret*, $\text{NPh}_2 \cdot \text{CO} \cdot \text{NH} \cdot \text{CS} \cdot \text{NH}_2$, is precipitated on mixing the calculated quantity of alcoholic ammonia with the isothiocyanate solution; it forms long, yellow prisms melting at 183° , and when fused with chloracetic acid, yields *n-diphenylcarbamylthiourantoin*, $\text{NPh}_2 \cdot \text{CO} \cdot \text{N} \cdot \text{C} \begin{smallmatrix} \text{S}-\text{CH}_2 \\ \text{NH} \cdot \text{CO} \end{smallmatrix}$ (*Trans.*, 1897, 71, 638), which is deposited from alcohol in tufts of flexible needles, melts at $184\text{--}185^\circ$, and is hydrolysed by potash, forming thioglycollic acid. *a-Benzyl-phenyl-c-diphenylthiobiuret*, $\text{NPh}_2 \cdot \text{CO} \cdot \text{NH} \cdot \text{CS} \cdot \text{NPhBz}$, from benzyl-aniline, occurs in white needles, becoming electrical on friction and melting at $137\text{--}138^\circ$. *a-Diphenylcarbamyl-β-phenylthiosemicarbazide*, $\text{NPh}_2 \cdot \text{CO} \cdot \text{NH} \cdot \text{CS} \cdot \text{NH} \cdot \text{NHPh}$, melts at $152.5\text{--}153^\circ$. *Benzylic*

a-diphenyl- β -thioallophanate, from the isothiocyanate and benzylic alcohol, occurs in vitreous, apparently rhombic, prisms melting at 141—142°; attempts to form similar compounds with methylic, ethylic, and cinnamic alcohols failed.

(2) *Methylphenylcarbamyliisothiocyanate*, $\text{NMePh} \cdot \text{CO} \cdot \text{NCS}$, with aniline, yields *a*-phenyl-*c*-methylphenylthiobiuret, $\text{NMePh} \cdot \text{CO} \cdot \text{NH} \cdot \text{CS} \cdot \text{NHPh}$, in woolly masses of needles melting at 158—159°. *a*-Orthotolyl-*c*-methylphenylthiobiuret forms thick, vitreous prisms melting at 108°; the *paratolyl* derivative occurs in white, glistening plates melting at 156—157°. *ac*-Dimethylphenylthiobiuret forms leafy crystals melting at 90—91°. *c*-Methylphenylthiobiuret, $\text{NMePh} \cdot \text{CO} \cdot \text{NH} \cdot \text{CS} \cdot \text{NH}_2$, crystallises in brilliant, apparently clinorhombic, prisms melting at 166—167°; with chloracetic acid, it yields *n*-methylphenylcarbamyli-thiourantoin, $\text{NMePh} \cdot \text{CO} \cdot \text{N} : \text{C} \begin{smallmatrix} \text{S}-\text{CH}_2 \\ \text{NH} \cdot \text{CO} \end{smallmatrix}$ a yellowish, crystalline powder melting at 199—200°, and giving thioglycollic acid on hydrolysis. *a*-Methylphenylcarbamyli- β -phenylthiosemicarbazide crystallises from alcohol in brilliant prisms, melting at 119—120°; no evidence was obtained of the production of a stereo-, or other, isomeride. Benzylic *a*-methylphenyl- β -thioallophanate, $\text{NMePh} \cdot \text{CO} \cdot \text{NH} \cdot \text{CS} \cdot \text{OBz}$, forms vitreous rhombohedra melting at 90—91°.

(3) *Ethylphenylcarbamyliisothiocyanate*, $\text{NEtPh} \cdot \text{CO} \cdot \text{NCS}$, forms the following derivatives:—*a*-Phenyl- γ -ethylphenylthiobiuret, melting at 106—107°; the *orthotolyl* and *paratolyl* compounds, melting at 124—125° and 174° respectively. *c*-Ethylphenylthiobiuret occurs in large, greasy-looking, flattened prisms melting at 147—148°, and yielding, with chloracetic acid, *n*-ethylphenylcarbamyli-thiourantoin, melting at 184—185°. Benzylic-*a*-ethylphenyl- β -thioallophanate crystallises in colourless prisms melting at about 120°.

(4) *Benzylphenylcarbamyliisothiocyanate*, $\text{NPhBz} \cdot \text{CO} \cdot \text{NCS}$, resembles its congeners in forming a yellowish solution which has no distinctive odour, and can be desulphurised in the cold by ammoniacal nitrate of silver, or by boiling with alkaline lead tartrate. *a*-Phenyl-*c*-benzylphenylthiobiuret, $\text{NPhBz} \cdot \text{CO} \cdot \text{NH} \cdot \text{CS} \cdot \text{NHPh}$, occurs in colourless prisms melting at about 103°; the corresponding *a*-*orthotolyl* compound melts at 131—132°, and when desulphurised, in presence of ammonia, by silver nitrate, yields a *guanidine*, $\text{NPhBz} \cdot \text{CO} \cdot \text{NH} \cdot \text{C}(\text{NH}) \cdot \text{NHTo}$, melting at 136—136.5°. *a*-Methyl-*c*-benzylphenylthiobiuret forms white prisms melting at 99—100°; the *a*-ethyl derivative melts at 67—68°. *c*-Benzylphenylthiobiuret crystallises from a mixture of chloroform and alcohol in lustrous, rectangular prisms; it melts at 179—180°, and with chloracetic acid, yields the compound, $\text{NPhBz} \cdot \text{CO} \cdot \text{N} : \text{C} \begin{smallmatrix} \text{S}-\text{CH}_2 \\ \text{NH} \cdot \text{CO} \end{smallmatrix}$, a sandy, crystalline powder melting between 194° and 195°, and

affording thioglycollic acid on hydrolysis by potash. *Benzyl a-benzylphenyl-β-thioallophanate* separates from hot alcohol in brilliant, vitreous prisms melting at 133—134°.

(5) *Oxanilylthiocyanate*, $\text{NHPh} \cdot \text{CO} \cdot \text{CO} \cdot \text{NCS}$, is obtained from phenyloxamic (oxanilic) chloride and lead thiocyanate in presence of toluene; its solution, when mixed with aniline, yields *a-phenyloxamyl-β-phenylthiocarbamide*, $\text{NHPh} \cdot \text{CO} \cdot \text{CO} \cdot \text{NH} \cdot \text{CS} \cdot \text{NHPh}$; it melts at 172—173°, and slowly dissolves in hot potash, producing phenylthiourea.

40. "A reaction of some phenolic colouring matters." By A. G. Perkin.

In a preliminary communication (*Proc.*, 1898, 14, 56) it was shown that some phenolic colouring matters which dye mordanted fabrics decompose the alkaline acetates in presence of alcohol, forming monosubstituted salts. The present investigation indicates the general nature of this reaction in the case of colouring matters having hydroxyl radicles in relatively ortho-positions, although in the flavone groups some exceptions occur. In the following list of the salts prepared, those of calcium and barium have been formed by double decomposition from the alkali compounds. The colour and crystalline form are given only in the case of the potassium salt, and all were obtained crystalline unless otherwise stated.

Anthraquinone Group.—Potassium alizarine, $\text{C}_{14}\text{H}_7\text{O}_4\text{K}$, violet needles; sodium alizarine, $\text{C}_{14}\text{H}_7\text{O}_4\text{Na}$; barium alizarine, $(\text{C}_{14}\text{H}_7\text{O}_4)_2\text{Ba}$; calcium alizarine, $(\text{C}_{14}\text{H}_7\text{O}_4)_2\text{Ca}$, and potassium monobromalizarine, $\text{C}_{14}\text{H}_6\text{BrO}_4\text{K}$. Potassium anthragallol, $\text{C}_{14}\text{H}_7\text{O}_5\text{K}$, violet-black needles; also $\text{C}_{14}\text{H}_7\text{O}_5\text{Na}$; $(\text{C}_{14}\text{H}_7\text{O}_5)_2\text{Ba}$ (amorphous), and $(\text{C}_{14}\text{H}_7\text{O}_5)_2\text{Ca}$ (amorphous). Potassium purpurine, $\text{C}_{14}\text{H}_7\text{O}_5\text{K}$, and sodium purpurine, $\text{C}_{14}\text{H}_7\text{O}_5\text{Na}$, red needles. Potassium anthrapurpurine, $\text{C}_{14}\text{H}_7\text{O}_5\text{K}$, red needles. Other colouring matters of this group behave similarly, but quinizarine and methoxyanthraquinone do not give the reaction.

Flavone Group.—Morin yields the orange-yellow compounds, $\text{C}_{15}\text{H}_9\text{O}_7\text{K}$; $\text{C}_{15}\text{H}_9\text{O}_7\text{Na}$; $(\text{C}_{15}\text{H}_9\text{O}_7)_2\text{Mg}$; $(\text{C}_{15}\text{H}_9\text{O}_7)_2\text{Ba}$; $\text{C}_{15}\text{H}_5\text{Br}_4\text{O}_7\text{K}$; $\text{C}_{15}\text{H}_4\text{Br}_4\text{O}_7\text{K}_2$ (amorphous), and quercetin, $\text{C}_{15}\text{H}_9\text{O}_7\text{K}$; $\text{C}_{15}\text{H}_9\text{O}_7\text{Na}$; $(\text{C}_{15}\text{H}_9\text{O}_7)_2\text{Ba}$ (?); $\text{C}_{15}\text{H}_7\text{Br}_2\text{O}_7\text{K}$, orange coloured. Rhamnetin and rhamnazin are peculiar, and give respectively the salts $\text{C}_{16}\text{H}_{12}\text{O}_7$, $\text{C}_{16}\text{H}_{11}\text{O}_7\text{K}$ and $\text{C}_{17}\text{H}_{14}\text{O}_7$, $\text{C}_{17}\text{H}_{13}\text{O}_7\text{K}$. Potassium rutin, $\text{C}_{27}\text{H}_{31}\text{O}_{16}\text{K}$; potassium violaquercitrin, $\text{C}_{27}\text{H}_{25}\text{O}_{15}\text{K}$; potassium myrticolarin, $\text{C}_{27}\text{H}_{27}\text{O}_{16}\text{K}$, and potassium xanthorhamnin, $\text{C}_{28}\text{H}_{36}\text{O}_{17}$, $\text{C}_{28}\text{H}_{35}\text{O}_{17}\text{K}$ (?), are yellow, amorphous powders. Fisetin forms $\text{C}_{15}\text{H}_9\text{O}_6\text{K}$, yellow needles, and myricetin, $\text{C}_{15}\text{H}_{10}\text{O}_8$, and luteolin, $\text{C}_{15}\text{H}_{10}\text{O}_6$, behave similarly, the

latter with production of very soluble salts. Apigenin, $C_{15}H_{10}O_5$, and chrysin, $C_{15}H_{10}O_4$, do not give the reaction.

In the *xanthone* group, gentisin and euxanthone do not yield salts in this manner, but galloflavin (Bohn and Graebe, *Ber.*, 1887, 20, 1329), a possible member, forms the salt, $C_{13}H_4O_9K_2$, described previously. Maclurin, $C_{13}H_{10}O_6$ (pentahydroxybenzophenone), gives a readily soluble compound, and alizarine yellow A (trihydroxybenzophenone) the salt $C_{13}H_9O_4K$. Cotoin and phloretin do not give the reaction.

Potassium and sodium hæmatein, $C_{16}H_{11}O_6K$, and $C_{16}H_{11}O_6Na$, are described, but compounds of brazilein, $C_{16}H_{12}O_5$, are too soluble for isolation. Santalin, $C_{15}H_{14}O_5$ (?), forms $C_{30}H_{27}O_{10}K$ (amorphous) and curcumin appears to form an analogous compound. From morin, quercetin, and alizarine, alkali salts are formed by boiling alcoholic potash, by carbonates, nitrites, succinates, lactates, benzoates, and salicylates in the presence of absolute alcohol, and by potassium acetate in the cold. Morin appears to form the compound $(C_{15}H_{10}O_7)_2 \cdot C_2O_4K_2$ with potassium oxalate. The salts of the anthraquinone group dissolve unchanged in boiling water; those of the flavone, xanthone, and benzophenone groups are decomposed, forming the colouring matter.

From potassium alizarine, $C_{14}H_7O_4K$, the ethers $C_{14}H_7O_3 \cdot OMe$ and $C_{14}H_7O_3 \cdot OEt$ are formed from the iodides at 230° . Ethylanthragallol, $C_{14}H_7O_4 \cdot OEt$, was also obtained. These contain the alkyl group in the meta-position, have previously been prepared by Schunck and Marchlewski (*Trans.*, 1894, 65, 185), and by Liebermann and Jellineck (*Ber.*, 1888, 21, 1169), and indicate the position of the acidic hydroxyl.

Monomethyl purpurine, $C_{14}H_7O_4 \cdot OMe$, evidently $[OH : OCH_3 : OH = 1 : 2 : 4]$, forms red needles melting at $228-230^\circ$. Ethers of quercetin were not isolated in this manner, in consequence of accompanying decomposition.

To account for the acidic nature of these colouring matters, a change in the quinonoid form is suggested, capable of existence only in the form of a salt. Such a constitution has previously been proposed (*Trans.*, 1896, 69, 1439) to explain the acid compounds of the flavone group, and a comparison of the *acid* and *basic* properties of these colouring matters reveals important points of resemblance.

Potassium alizarine, $C_{14}H_7O_4K$, is converted by cold acetic anhydride into *monacetylalizarine*, $C_{14}H_7O_4Ac$, crystallising in orange-yellow needles which melt at $198-201^\circ$; when allowed to remain some weeks with the reagent, diacetylalizarine is produced. Potassium-morin in the cold forms *tetracetylmorin*, $C_{15}H_6O_7Ac_4$, which crystallises in colourless, prismatic needles, melts at $142-145^\circ$, and subsequently passes into a very soluble derivative. Potassium quercetin, $C_{15}H_9O_7K$, similarly gives *triacylquercetin*, $C_{15}H_7O_7Ac_3$, melting at $167-169^\circ$,

and quercetin sulphate, $C_{15}H_{10}O_7 \cdot H_2SO_4$, a *tetracetyl* compound which forms colourless needles melting at 193—194°.

The salts of morin and quercetin (Hlasiwetz and Pfaundler, *Jahresb.*, 1864, 560), of quercitrin (Liebermann and Hamburger, *Ber.*, 1879, 12, 1179), of fisetin (Schmid, *Ber.*, 1886, 19, 1739), and curcumin (Jackson and Menke, *J. Amer. Soc.*, 1882, 4, 77) appear to have been mixtures, as their percentage composition, though coinciding with the older formulæ of these colouring matters, does not agree with that required by their correct molecular weight.

41. "Note on the optical activity of gallotannic acid." By Otto Rosenheim, Ph.D., and Philip Schidrowitz, Ph.D.

In a recent communication (*Trans.*, 1898, 73, 878), the authors stated that the optical activity of gallotannic acid was first observed by F. M. Flawitzky, and that Günther independently rediscovered it in 1895, Flawitzky's communication remaining unnoticed. During the course of an investigation on the formation of gallic acid from gallotannic acid by the action of moulds, one of the authors (R.) has found that the merit of having first discovered the optical activity of the substance undoubtedly belongs to Ph. van Tieghem, who in a paper on "Fermentation du Tannin," says: "*Je me suis assuré que le tannin dévie vers la droite le plan de polarisation de la lumière incidente,*" and (*Ann. des Sciences Nat.*, 1867, [v], 8, 210) gives the specific rotation of the acid as $[\alpha]_{D16} + 38.1^\circ$. This communication seems to have been unknown to Schiff, who six years later (*Annalen*, 1873, 170, 75) devised the accepted gallotannic acid formula, and directly alluded to the 'inactivity' of this substance, quoting F. W. Krecke's observations (*Arch. Néerl.*, 1871, 6, 193). It is remarkable that the important optical properties of this substance have been thrice discovered independently, and that until quite recently these have not become generally known and are not mentioned in any of the best known text- or hand-books. The fact that van Tieghem did not mention his discovery in a report on the subject (*Compt. rend.*, 1867, 65, 109), and that his original communication appeared in a botanical journal more or less inaccessible to chemists, may account in part for this omission.

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I. Donations.

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Roscoe, H. E., und Schorlemmer, C. *Ausführliches Lehrbuch der Chemie*. Fortgesetzt von J. W. Brühl. Fünfter Band. Die Kohlenwasserstoffe und ihre Derivate, oder organische Chemie. Dritter Theil. Bearbeitet in Gemeinschaft mit Edvard Hjelt und Ossian Aschan. Zweite Abtheilung. Pp. 465—1048 + xi. 8vo. Braunschweig 1896.

— Sechster Band. do. Vierter Theil. do. Pp. xii + 709. 1898.

From the Publishers.

ANNIVERSARY MEETING.

The Anniversary Meeting will be held on Wednesday, March 29th, at 3 o'clock in the afternoon.

NOTICE TO AUTHORS.

As the *Proceedings* go to press on the Monday after each ordinary Meeting of the Society, the announcement of papers for the next Meeting cannot be made in this publication unless the papers are in the hands of the Secretaries by noon on that day.

At the next meeting, on Thursday, March 16th, 1899, the following papers will be communicated:—

“Influence of substitution on specific rotation in the bornylaminic series.” By M. O. Forster, Ph.D.

“Rotatory power of optically active methoxy- and ethoxy-propionic acids prepared from active lactic acid.” By Thomas Purdie, F.R.S., and James C. Irvine, B.Sc.

PROCEEDINGS
OF THE
CHEMICAL SOCIETY.
EDITED BY THE SECRETARIES.

Vol. 15.

No. 206.

March 16th, 1899. Professor Dewar, F.R.S., President, in the Chair.

Messrs. E. Szarvasy, E. B. Fairweather and Arnold Stevenson were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. Frank Belton, 103, Lower Seedley Road, Pendleton, Manchester; Robert D. Connell, 38, Chapel Road, Stamford Hill, N.; Harold Francis Carl Goltz, 7, Craster Road, Upper Tulse Hill, S.W.; Robert William Lindsey, 22, Hildrop Crescent, Camden Road, N.; James MacLeod, Westhill, Cardcross Road, Dumbarton; Allan Frederick Walden, New College, Oxford.

The PRESIDENT announced that he desired to present to the Society a daguerreotype of Dalton, which was one of two taken in 1842. The daguerreotype came into the possession of Mr. Dancer, a philosophical instrument maker of Manchester, who, it might be interesting to state, constructed Joule's thermometers and apparatus, and it was from Mr. Dancer's relatives that he had acquired the portrait. He felt that so interesting a memorial of such a man ought not to remain in the possession of a private individual, and it seemed fitting that its custody should be entrusted to the Chemical Society; he therefore presented it to the Society on the understanding that steps should be taken to ensure its safe preservation.

Through the kindness of Mr. S. W. Woolley, he had received an interesting card which appeared to have been used by Dalton during the meeting of the British Association at Manchester in 1842. This card bears his autograph and an embossed head. Accompanying it was an engraved sheet of symbols representing atomic combinations, which had been prepared to illustrate a paper read by Dalton at this meeting. These he also desired to present to the Society, to be included in the collection of memorials of illustrious chemists which was being gradually formed.

On behalf of the meeting, Professor TILDEN thanked the PRESIDENT for the gift of the daguerreotype, which would be preserved with all the

care and solicitude which such an interesting memorial deserved. He added that he believed the well known portrait of Dalton engraved by Jeans, and appearing as the frontispiece in Roscoe and Schorlemmer's Treatise on Chemistry, was prepared from a drawing made from this daguerreotype.

Of the following papers, those marked * were read.

- *42. "The boiling point of liquid hydrogen as determined by a rhodium-platinum resistance thermometer." By James Dewar, LL.D., F.R.S.

The difficulties in liquefying hydrogen caused by the presence of air in the gas have been referred to (*Proc.*, 1898, 14, 130), and later experiments have had for their object the removal of this fruitful source of trouble. This is by no means easy, as quantities amounting to only a fraction of a per cent. accumulate in the solid state, and eventually choke the nozzle of the apparatus, necessitating the abandonment of the operation. Within the last week, the author had succeeded in obtaining 250 c.c. of colourless liquid hydrogen, and this had been employed in a re-determination of the boiling point. Earlier observations (*ibid.*, 146), made with a pure platinum resistance thermometer, had given -238° as the boiling point, and a new thermometer, constructed from pure platinum from a different source, gave practically the same result. As this might be affected by some constant error, the determination was checked by employing a thermometer constructed from an alloy of rhodium and platinum, containing 10 per cent. of the former. Alloys had been shown by Professor Fleming and the author to differ from pure metals in showing no sign of becoming perfect conductors at the absolute zero of temperature, and a study of the rhodium-platinum alloy had shown that the change in conductivity produced by cooling from 0° to the boiling point of liquid air is regular, and may be represented by a straight line. As determined by the rhodium-platinum thermometer, the boiling point of hydrogen was found to be -246° . Two ways of explaining the discrepancy between the two determinations suggested themselves. Pure platinum, although its resistance may be represented by a straight line almost down to the solidifying point of air, shows signs of a departure from regularity at about this point, and the curve may become asymptotic at lower temperatures. On the other hand, the resistance of the rhodium-platinum alloy diminishes less rapidly at these lower temperatures and is much higher than that of pure platinum under similar conditions. It follows that its resistance-temperature curve, in all probability, deviates less from a straight line than is the case with platinum. Either cause would explain the differences observed, but the lower boiling point, -246° , or 27° absolute, seemed to be the more probable, as it agreed very fairly with the value for the boiling point calcu-

lated by the author from Wroblewski's results and that arrived at by Olszewski. As the use of other pure metals or alloys could not lead to more satisfactory results, the problem must be attacked in a different way by means of an "air" thermometer containing hydrogen under diminished pressure.

Addendum, March, 17th, 1899.—Since this paper was communicated, the author has made a first attempt at determining the boiling point by a constant volume hydrogen thermometer working under diminished pressure. The result is that this thermometer, which gave the boiling point of oxygen as 90.5° absolute or -182.5° , gave for hydrogen 21° absolute or -252° . The three determinations that have been made are then as follows: (1) pure platinum resistance thermometer, 35° absolute; (2) rhodium-platinum resistance thermometer, 27° absolute; (3) Hydrogen thermometer, 20° absolute. From this it appears that the boiling point of hydrogen is really lower than was anticipated. The experiment will be repeated with thermometers filled with hydrogen prepared from different sources. The boiling point should be determined by the use of a hydrogen thermometer filled with gas obtained from the evaporation of the liquid hydrogen itself.

***43. "Influence of substitution on specific rotation in the bornylamine series." By M. O. Forster, Ph.D., B.Sc.**

Certain alkyl derivatives of bornylamine have been prepared, in order to ascertain the effect produced by substitution on the specific rotatory power of the base. The following observations have been made :—

1. The specific rotation of bornylamine is largely increased by the replacement of a single hydrogen atom in the amino-group by an alkyl radicle.

2. In ascending the homologous series of monalkyl derivatives, a maximum specific rotation occurs at the ethylic term; if the molecular rotation is considered, the maximum appears at the propylic term.

3. A maximum specific and molecular rotation, occurring at the ethylic term, is also met with in the two series comprising the hydriodides and the benzoyl derivatives of the homologous bases.

4. The specific rotation of bornylamine is slightly increased on replacing both hydrogen atoms in the amino-group by alkyl radicles, but the magnitude of this increase is inconsiderable when compared with that produced by substituting an alkyl radicle for a single atom of hydrogen.

5. The specific rotatory power of paranitrobenzylbornylamine approximates more closely to that of benzylbornylamine than does that of the orthonitro-compound, but this does not apply to the molecular rotation.

6. When an alkyl group replaces hydrogen of the ammonium radicle in the series of alkylbornylammonium iodides, the specific rotatory power of bornylamine hydriodide, instead of undergoing increase in the positive direction, becomes reduced to feeble lævorotation.

7. The monalkylbornylamines, although strongly dextrorotatory, give rise to benzoyl derivatives which are strongly lævorotatory.

The following bases have been prepared and examined. *Methylbornylamine, dimethylbornylamine, ethylbornylamine, diethylbornylamine, normal propylbornylamine, isopropylbornylamine, butylbornylamine, benzylbornylamine, orthonitrobenzylbornylamine, and paranitrobenzylbornylamine.* Certain salts of these compounds have been also characterised.

DISCUSSION.

Dr. ARMSTRONG said that mere simple relations of mass were by no means the sole controlling influences in the case of other properties, and it would be surprising had optical activity been found to be an exception to the rule. In all experiments on optically active compounds, it was difficult to discount the effect of association which, as other workers in the field had suggested, might afford an explanation of divergencies in a series of homologues such as those recorded by the author. The marked differences in the rotatory powers of the alkyl- as compared with the dialkyl-bornylamines, was only an additional illustration of the fact that asymmetry has an influence entirely different from that of symmetry on the properties of substances.

Dr. LEWKOWITSCH suggested that interesting results would be obtained if the author were able to prepare a homologue of dimethylbornylamine methiodide in which the two methyl groups were replaced by two different alkyl groups of greater mass, say, by propyl and butyl respectively. The nitrogen would thus become asymmetric, and as, from Le Bel's experiments (*Compt. rend.*, 1890, 110, 144), it might be expected that optical activity would ensue, the examination of a product containing asymmetric carbon and nitrogen atoms could not fail to give important results.

Dr. CROSSLEY remarked that the curious behaviour of the isopropyl group, referred to by the author, was not at all uncommon in the case of ethereal salts of substituted malonic acids. For example, α -ethyl- and $\alpha\alpha'$ -methylethyl-pimelic acids could be prepared by the interaction of the ethereal salts of corresponding substituted malonic acids with trimethylene chlorobromide (*Trans.*, 1894, 65, 987), but similar experiments made with the object of preparing methylisopropylpimelic acid had not given satisfactory results, and up to the present had not been completed. Another example was to be found in the preparation of ethylisopropylacetic acid from the corresponding malonate, the introduction of the isopropyl group being attended

with great difficulty. It would be of interest to know what was the effect on the rotatory power of substituting dissimilar alkyl radicles in bornylamine.

Dr. FORSTER, in reply, stated that practical difficulties had hitherto prevented the examination of the derivatives of bornylamine to which Drs. Lewkowitsch and Crossley had referred. It had not been possible to prepare by direct methods either unsymmetrical alkyl-bornylammonium iodides or dialkylbornylamines, but this object had been kept in view, and an attempt would be made to deal with the question at some future time.

***44. "Contribution to the characterisation of racemic compounds."**

By A. Ladenburg, For. Mem. C.S.

The author refers to the fact that his definition of racemism has not received confirmation from the experiments of Kipping and Pope, but believes that the principle involved in it is correct and has only been expressed in a misleading manner. He therefore substitutes the following: To characterise an inactive substance, determine its solubility with and without the addition of one or other of its optically active components at the same temperature and with the same solvent. If the solubilities are different, the substance is a racemic compound, if the same, it is an enantiomorphous mixture. Experiments with racemic acid, *i*-pyrotartaric acid, and an inactive mixture of sodium ammonium *d*- and *l*-tartrates are given in support of this view.

DISCUSSION.

Mr. W. J. POPE said he was gratified to learn that Professor Ladenburg agreed with the criticism passed by Kipping and himself (*Trans.*, 1899, 75, 36) upon the older work respecting the characterisation of racemic compounds. The amended form into which Professor Ladenburg cast his statement was not, however, identical in principle with the older one, as the two statements involved absolutely different principles. The older statement said that the solution of a non-racemic optically active mixture of antipodes should deposit, on crystallisation, a mixture of the antipodes of the same composition as that in solution; this view Kipping and he had shown to be untenable. Professor Ladenburg's new statement was quite independent of any similarity of composition between the mixture in the solution and that in contact with the solution; it merely embodied the principle which Kipping and he had stated and shown to be true by experiments on mixtures of sodium ammonium dextro- and lævo-tartrates, namely, that the most soluble non-racemic mixture of two enantiomorphously related substances is a mixture in equal proportions. The facts (*a*) that a racemic compound had a different solubility alone than when mixed with one of its enantiomorphous constituents, and (*b*) that an

inactive non-racemic mixture of two antipodes had the same solubility as a mixture containing excess of one constituent, were simple consequences of the phase rule. In case (a), the solution in equilibrium with the racemic compound was saturated with respect to a single substance only, but on adding one of the active components, the solution became either saturated with respect to two substances—the racemic and the active—or saturated with regard to the racemic substance and partially saturated with respect to the active substance; in either case, as Professor Ladenburg found with the tartaric and pyrotartaric acids, the solution changed in concentration. In case (b), the solution in equilibrium with, and in contact with, the non-racemic inactive mixture was saturated with respect to both *d*- and *l*-constituents, and addition of excess of one solid constituent did not affect the mixture going into solution, because it did not alter the solid phases in contact with the solution. Thus Professor Ladenburg found the solubility of a compensated mixture of sodium ammonium *d*- and *l*-tartrate to be the same as that of non-compensated mixtures; from the work of Kipping and himself, it was to be premised, not only that the solutions were in both cases equally concentrated, but were both inactive, containing equal quantities of the *d*- and *l*-isomerides. He could not agree with the view that Professor Ladenburg's experiments proved that "ammonium sodium *d*- and *l*-tartrate remain uncombined in the solution"; the experiments proved merely that the *d*- and *l*-salt in contact with the solution were uncombined, but threw no light on the condition of the dissolved material. Professor Ladenburg's new statement was indisputable; it was corroborated by the work of Kipping and himself, and had nothing in common with his older definition of racemism.

Dr. LEWKOWITSCH suggested that the examination of a racemic compound which was more soluble in water than its optical isomerides would complement in some way the results obtained with racemic acid, which was less soluble than either dextro- or lævo-tartaric acid.

45. "Rotatory powers of optically active methoxy- and ethoxy-propionic acids prepared from active lactic acid." By Thomas Purdie, F.R.S., and James C. Irvine, B.Sc.

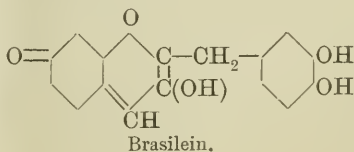
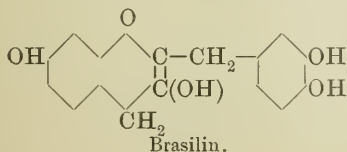
The authors have applied the method of alkylating the ethereal salts of hydroxy-acids by means of alkyl iodides and silver oxide (*Trans.*, 1899, 75, 157) to levorotatory methylic and ethylic lactates, and have obtained methylic methoxypropionate and ethylic ethoxypropionate, the specific rotations of which at 20° were found to be -95.53° and -79.69° respectively. These high values, and the fact that the rotations are of the same sign as that of the lactates, confirm the conclusion that the alkyl lactates made from the silver salt owe their high activity to the presence of small quantities of alkyloxypropionates.

Anhydrous methoxy- and ethoxy-propionic acids, as well as ethylic methoxy- and methylic ethoxy-propionates, were prepared; the molecular rotations of the anhydrous acids were about equal to one another, and those of the methoxypropionates higher than those of the corresponding ethoxy-compounds, a result which seemed to be at variance with previous observations (*Trans.*, 1898, 73, 862) on the metallic salts of the same acids otherwise obtained, according to which the methoxypropionates were the less active. The molecular rotations of the metallic salts of the two acids obtained as above, however, confirm the previous observations. Curves representing the decrease of rotation with increasing concentration show that the factor causing the decrease has a greater effect on the methoxy- than on the ethoxy-salts, and that the difference is more marked in the case of the salts of divalent metals.

The rotations of the acids in aqueous solution are less than in the anhydrous state, and are nearly constant on dilution, that of the methoxy-acid, as in the case of the ethereal salts, being the higher. It seems probable that the anhydrous acids contain molecular aggregates of higher activity than the individual molecules or ions, and that the higher activity of the methoxy-acid in aqueous solution, as compared with the ethoxy-acid, is due to the acid, like the salts, being more influenced by this factor.

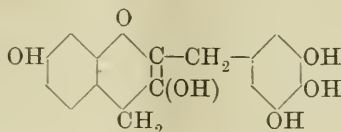
46. "On Brasilin and Hæmatoxylin. II." By A. W. Gilbody and W. H. Perkin, jun.

In continuing their investigations on the constitution of these substances, the authors oxidised dimethylbrasilin with permanganate, and obtained in this way an acid melting at 173° , which, on analysis, gave numbers agreeing with those required for the formula $C_{10}H_{10}O_6$. This acid is dibasic, the silver salt having the formula $C_{10}H_8Ag_2O_6$; it is characterised by great stability, permanganate only attacking it with difficulty at 100° ; it gives no coloration with ferric chloride, but when fused with potash, and the acidified product extracted with ether, a substance is obtained which gives with ferric chloride an intense violet coloration, and is, therefore, probably resorcinol, or one of its derivatives. After a careful study of the various new oxidation products described in their previous communication (this vol., 27), the authors conclude that brasilin and brasilein are probably represented by the formulæ:—



but they must reserve for the detailed paper the reasons which have led them to this conclusion.

If the formula for brasilin should prove to be correct, the constitution of hæmatoxylin will probably be represented by the formula:—



from which a formula for hæmatein similar to that assigned to brasilein can readily be deduced.

47. "Crystallisation of dynamic isomerides. A correction." By
T. M. Lowry, B.Sc.

In his paper on "Nitrocamphor as an Example of Dynamic Isomerism," the author states (*Trans.*, 1899, 75, 231) that the laws governing the crystallisation of isodynamic substances had not yet been discussed, and the behaviour of nitrocamphor and π -bromonitrocamphor on crystallisation is used as a basis for the theoretical treatment of the subject. A paper by Roozeboom, entitled "Ueber die Erstarrung flüssiger Mischungen tautomerer Stoffe," which has just appeared (*Zeit. physikal. Chem.*, 1899, 28, 289), has drawn the author's attention to the fact that he had unfortunately overlooked the full theoretical discussion of the subject by Bancroft in two papers on "The Equilibria of Stereoisomers" (*J. Physical Chem.*, 1898, 2, 143, 245). The behaviour of nitrocamphor and π -bromonitrocamphor, and the conclusions arrived at from the study of these two special cases, are completely in accord with the general laws deduced by Bancroft.

ANNIVERSARY MEETING.

The Anniversary Meeting will be held on Wednesday, March 29th, at 3 o'clock in the afternoon.

At the next ordinary meeting, on Thursday, April 20th, the following paper will be communicated:—

"On some dipyrindine derivatives from citrazinic acid." By W. J. Sell, M.A., and H. Jackson, B.A., B.Sc.

PROCEEDINGS
OF THE
CHEMICAL SOCIETY.
EDITED BY THE SECRETARIES.

Vol. 15.

No. 207.

March 29th, 1899. Anniversary Meeting. Professor Dewar, F.R.S.,
President, in the Chair.

Dr. E. W. Voelcker and Mr. W. P. Bloxam were appointed Scrutators, and a ballot was opened for the election of Officers and Council for the ensuing year, the ballot being closed at the conclusion of the President's address.

The PRESIDENT, in beginning his address, said that the past two years had been marked by change in the ranks of the active officers of the Society. Last year, Professor Thomson, who had been an Honorary Secretary since March, 1883, resigned office. His services to the Society had been beyond praise, not only from the amount of work actually done, of forethought and care expended, but also from the personal influence which enabled him to discharge the often delicate duties of his office without wounding the susceptibilities of those with whom he had to deal. Dr. Wynne, who became Junior Secretary last year, had now resigned the post to take up the arduous duties of Editor of the Society's Journal. Dr. Thorpe, who had been honorary Treasurer since 1889, vacated the office that day, the eminent services which he has rendered, not only to Chemical Science, but to the Society, recommending him to the Council for the highest honour the Society had to bestow. Dr. Tilden, who had served the Society twice as Vice-President, would succeed him as Treasurer, and Dr. Scott had been nominated to succeed Dr. Wynne as Secretary. The names of these gentlemen were familiar to the Society as those of persons in every way qualified to discharge the duties of their respective offices.

The Treasurer, as he might still for some minutes call him, would no doubt render them an account of his stewardship, but the duty was incumbent upon him of expressing their deep sense of the debt of gratitude owed him by the Society. During 10 years of office, despite the magnificent undertakings of which Dr. Thorpe had been the mainstay, the investments of the Society had increased by one-half, and its income had risen from £4150 to £5286, while, largely

owing to his vigilant care, the tendency to an increased expenditure had been kept down to normal proportions.

During his term of office he had had to provide the funds for some very considerable undertakings, chief amongst which were the alterations effected in the meeting room and the introduction of the electric light in 1892, the Society's Jubilee in 1891, and the drawing up of General Indexes to the Society's Journal and the Abstracts from 1873 to 1892. On the completion of this latter piece of work, which Dr. Thorpe would announce to the meeting, it seemed a fitting time to acknowledge the service which the publication of these volumes has rendered to every one interested in the science. They had been issued gratuitously to all Fellows who had received the Journal during the period they cover, provided that application was made for them before December, 1895.

Though the initiative in this issue had been taken by our illustrious colleague, the main burden of the preparation of the Index had fallen on a lady, Mrs. Dougal, who edited the two volumes with zeal, energy, and intelligence. He (the President) would wish to bear testimony to her self-sacrificing devotion to this task, which had occupied upwards of five years. It had proved to be one of uncommon and unexpected difficulty. The annual indexing was found to have been done in an irregular and unsystematic way in the past, and much of the work which was understood to be ready to her hand had to be done over again. She had, both directly and indirectly, done the Society a great service—directly, by the compilation which she had executed, and indirectly, by leaving an example of thoroughness and accuracy to her successors. He had also to tender their thanks to the ladies who assisted her, and to Miss Neale, who had taken her place for a short time. The thanks of the Society were also due to the Index Committee, and more especially to Dr. Forster Morley, whose unwearied assistance and experience did much to solve the problems which were daily met with in the progress of the work.

The yearly indexes to the Journals had of late shown a tendency to expansion. With a view to making them of more service, a staff of Indexers, having a special knowledge of the various departments they undertook, had been engaged.

During the past year the Society was privileged to offer to six of its Past-Presidents its congratulations, and those of the whole Scientific world, on the occasion of their completing fifty years' Fellowship of the Society. The Banquet at which they were entertained would long live in their memory. To quote the words of Friedel, "No finer phalanx of the Fathers of our Science exists in any country." The occasion was too recent for him to add anything to the sentiments then expressed. The event, however, was not without a melancholy

side. As originally proposed, the foremost of this phalanx would have been their senior Past-President, the last surviving Founder of the Society. He would not speak here at length of the services Lord Playfair had rendered to Science, but fifty years' active work in the service of the Society required a more special mention. He became a Member of the Council in 1846, in 1850 he was elected a Vice-President, in 1857 he became President of the Society in succession to Professor Miller, and from 1859, for forty years, he remained Vice-President of the Society to which his experience and influence rendered signal service. His last appearance amongst them had been to propose him (Prof. Dewar) as President.

During the past two years, the Society had lost by death thirty-six of its Fellows. Lord Playfair was the last survivor of the seventy-seven original members of our Society. In Mr. J. W. Rodger, the Society lost one of the most promising of the younger men of science and a Member of its Council. Sir Thomas Dyke Acland had been a Fellow of the Society for over forty years, and though he had never taken an active part in the affairs of the Society, he had rendered great services to our Science in its connection with Agriculture. Sir Douglas Galton, whose recent loss they had to deplore, had been a Fellow of the Society for a quarter of a century. Mr. Newlands, whose "Law of octaves" has taken an imperishable place in the history of Science, was in his fortieth year of membership, and had also served the Society as a Member of Council. His portrait now occupied a place on their walls.

Mr. Groves, who had been connected with the Journal since 1878, first as Sub-Editor, and, in 1884, as Editor in succession to Mr. Watts, resigned office that day. Only those who have been connected with similar publications could measure the full extent of the Society's indebtedness to him, but they could all join the Council in expressing their deep sense of, and thanks for, the important services he had rendered to the Society during those twenty-one years. They could only express the hope that his work for the Society and for Science might be continued for many years to come.

Mr. Greenaway, who had for so many years occupied the important office of Sub-Editor, and worked so harmoniously with Mr. Groves, had elected to remain in that position. Dr. Wynne had succeeded Mr. Groves in the editorial chair and could be trusted to preserve that high level of excellence to which the Society's Journal had attained.

The number of papers read before the Society during the past two years was 274, of which 216 had since been published in full in the Society's *Transactions*, the remaining papers being preliminary notices of a more or less temporary character.

The Meetings of the Society had been well attended, and the

discussions fruitful of interest, but he could desire, in the best interests of the Society, that a larger proportion of the senior Members could find it possible to be present.

During the past two years considerable attention had been given by the Council to the question of a suggested revision of the Bye-Laws. It has been found that no important modification can be made in these without the grant of a new Charter, and it is thought that it is hardly worth while to introduce mere verbal changes which might, perhaps, make the meaning of the Bye-Laws more clear, but which, the Council is legally advised, are unnecessary in view of the established practice of the Society.

The next matter of importance which would engage the attention of the Society would probably be the issue of a new catalogue to the Society's Library. Originally founded in 1850, it then consisted of about 270 volumes of journals, 60 miscellaneous volumes, and 100 pamphlets. Its first catalogue was issued in 1851, a second catalogue was prepared by Mr. Watts and issued early in 1861, a third catalogue, now grown from 28 to 112 pages, was issued in 1869, and a fourth, of 138 pages, in 1874. In 1886, a new catalogue, arranged according to subject matter was drawn up by Mr. Warrington from Mr. Watts' notes, and issued to the Society. It extends to 327 pages, and has an Author-index drawn up by Professor McLeod. The catalogue of 1886 contains entries of 5580 volumes of journals, 4223 books, and 1380 pamphlets. Since that time there have been added 3279 volumes of journals, 1361 books, and over 1600 pamphlets. The preparation and issue of this important work would necessarily involve some considerable time and expense to the Society.

One of the great needs of scientific workers is a ready means of acquainting themselves with the bearing and results of general scientific work. The publication of Abstracts of particular branches of science is, generally speaking, nearly complete, but there is great overlapping and waste of energy. The suggestion has been made that some change analogous to that recently carried out by the German Chemical Society should be made in the publication of our own Abstracts. All such proposals will have the fullest consideration of the Council, but it is clear that it would be unwise to ignore the grave consequences to the financial position of the Society which might result from any too precipitate change in the method of publication of the Abstracts. Without entering more fully on this question, he might remark that there was still room for co-operation in this matter between the societies of this country.

They had been asked to co-operate with the American and the German Chemical Society in bringing about an International agree-

ment upon the subject of Atomic Weights. The Council has appointed a Committee to consider the matter.

In the meantime, they had had the opportunity of co-operating in the movements designed to honour the memory of two illustrious chemists, Kekulé and Davy; the former by joining in the International Memorial to his memory, the latter by contributing, in conjunction with the Royal Institution and the Royal Society, to a fund designed to restore and preserve the memorial raised over his grave.

The remainder of the address was of a general and theoretical nature, dealing with recent advances in Chemical research, principally in connection with low temperatures.

The numerical strength of the Society was as follows:—

Number of Fellows, March 31st, 1898	2140
„ „ since elected	132
„ „ reinstated by Council.....	3
	<hr/>
	2275
Removed on account of non-payment of two	
annual subscriptions	15
Withdrawn	12
Deaths	18
	<hr/>
	45
Number of Fellows, March 31st, 1899	2230
Foreign Members	38

The names of those removed were:—E. S. Cameron; F. E. J. Cridland; F. W. S. Glenfield; E. Hawkins; L. W. Hawkins; A. J. Heath; W. Hesketh; H. Heywood; J. Hulme; F. Ibbotson; J. E. W. McFall; T. A. Reid; B. E. Smith; J. H. Starling; F. H. Wigham.

The following have withdrawn:—Bennett F. Davenport; Henry Winram Dickinson; Arnold Eiloart; K. S. Engineer; C. H. Reissman; A. G. Scorer; Bomanji Sorabji; Walter J. Sykes; William Gilchrist White; John Williams; W. M. Wilson; B. Winstone.

The following have died:—Sir T. J. Dyke Acland; W. R. Burnett; Michael Conroy; E. Rider Cook; Ramchandra Dutta; George Foord; Sir Douglas Galton; Jeremiah Head; J. G. Heywood; W. L. Hiepe; Charles Lowe; J. A. R. Newlands; Eugen Obach; Lord Playfair; Manning Prentice; H. W. Seely; Matthew Smith; Samuel Spencer.

The number of communications made to the Society during the year was 150.

One hundred and two papers were published in the *Transactions*

for 1898, occupying 1047 pages, whereas in the preceding year 114 papers were published, occupying 1204 pages.

The following were the statistics relating to the Abstracts.

PART I.

	Pages.	No. of Abstracts.
Organic Chemistry	720	1187

PART II.

General and Physical Chemistry		344
Inorganic Chemistry		284
Mineralogical Chemistry		171
Physiological Chemistry.....		165
Chemistry of Vegetable Physiology and Agriculture		159
Analytical Chemistry.....		516
	660	1639
Total in Parts I. and II.	1380	2826

Seven hundred and twenty-seven volumes had been borrowed from the Library. The additions comprised 67 books, 285 volumes of periodicals, and 24 pamphlets.

Dr. GLADSTONE, F.R.S., proposed a vote of thanks to the President, coupled with the request that he would allow his address to be printed in the *Transactions*.

Dr. ARMSTRONG, F.R.S., seconded the motion, which was carried by acclamation.

The PRESIDENT having returned thanks,

Dr. THORPE, F.R.S., the Treasurer, in giving an account of the Balance Sheet which he laid before the Society, duly audited, said:—

The receipts had been:—By admission fees and subscriptions, £4064; by sale of Journal and advertisements, £740 15s.; and by dividends on invested capital, £428 2s. 1d. The expenses had been:—On account of the Journal, £3007 9s. 10d.; on account of the Proceedings, £287 6s. 10d.; on account of the General Index, £793 16s. 7d.; on account of the Library, £294 19s. 11d.; House expenses, £238 2s. 7d.; the total expenditure being £5415 6s. 8d. Grants amounting to £245 had been made to Fellows from the Research Fund during the year, and a sum of £1316 ls. had been invested in the purchase of £1400 India $2\frac{1}{2}$ per cent. Stock.

On laying down his office as Treasurer, to which he was elected in

1889, Dr Thorpe hoped that it might not be uninteresting to the Fellows if he gave a brief account of the financial progress of the Society during the ten years of his stewardship.

In 1889, the total assets of the Society, excluding the Research Fund, were £12,221; in 1899 they are £17,289.

The total assets of the Research Fund in 1889 were £5464; in 1899 they are £7618.

The aggregate total assets are now £24,907, as against £17,686 in 1889.

In 1889, the total receipts from Fellows were £3402; in 1899 they are £4064, or an increase of $19\frac{1}{2}$ per cent. The annual income from the sale of the Society's publications in 1889 amounted to £365; this year, including an outstanding item on account of advertisements, it is £760, or an increase of 108 per cent. This is due partly to the increased circulation of the Journal and partly to the increased price which can be obtained for it. The advertisements now bring in an income equivalent to about £2000 of funded property.

The total income of the Society from all sources in 1889 including the balances at the Bank was £5824; at the close of the present financial year it has amounted to £7180.

It will be seen, therefore, that whilst the receipts from the Fellows have increased by $19\frac{1}{2}$ per cent., the income of the Society has increased by 23·3 per cent., and the total assets, some of which may be counted upon to still further increase the annual income, have increased by 40·8 per cent.

But if it may be said of Societies, as of individuals, that their riches consist, not in the abundance of their possessions, but in the fewness of their wants, it is the experience of the Treasurer that the Chemical Society is by no means a rich corporation, for its wants advance, almost *pari passu*, with its possessions. His successor would find that, however ingenious he may be in securing money, the Society, with equal or with even greater ingenuity, will find a method of relieving him of it.

He regretted to find that he had—he hastened to add, by direction of the Council—signed cheques for a greater amount than any one of his predecessors. During the ten years he had been in office he had disbursed nearly £45,000 of the Society's money. In explanation of this, he might point out that the annual cost to the Society of its publications has steadily increased since 1889. In that year, the expenses connected with its publications came to £2565; this year, in spite of a considerable saving in the printer's bills, and in spite of the draconian methods of the Publication Committee, its publications, excluding the Collective Index, have cost £3370.

The expenses on account of the Library also steadily increase. In 1889, £196 was spent in books, periodicals, and binding; this year, which has been somewhat below the average of the preceding years, the amount has been £246.

The House expenses in 1889 came to £184; this year they are £238.

The total expenditure in 1889 was £3430; this year it has been £5415.

As regards these disbursements, he might be pardoned, perhaps, for pointing out that none of his predecessors had been called upon to spend so large an amount of the Society's money in what might be termed extraordinary expenditure. To begin with, his immediate predecessor handed him over—and it was his only legacy—certain applications for increase of salary on the part of the Editorial staff, and he was good enough to urge that he should deal with them liberally. The liberality has resulted in a difference of £1000 to the Society.

In 1891, the Society celebrated its Jubilee at a cost, notwithstanding the generous assistance of the Goldsmiths' Company, of about £450. In the following year, the alteration of the Meeting Room and the installation of the electric light was taken in hand, at a cost of £1490.

Shortly afterwards, the Society was called upon to provide for the declining years of an old and faithful servant. There was no circumstance connected with his official career as the Treasurer of the Society which he recalled with greater pleasure than its action in regard to Mr. Josiah Hall's pension.

In the early part of 1894, the Society determined to print a Collective Index of its publications from 1873 to 1892. This has proved to be even a more formidable undertaking than was expected. It has occupied nearly five years in execution, and has cost some £1740. It is now happily completed, and the Society may congratulate itself upon possessing an adequate key to the great store of chemical knowledge which it has accumulated during twenty years.

The revision of the Annual Indexes necessitated by this great work has shown the absolute need for their more systematic preparation. This has led to the establishment of a special staff of indexers, at an annual cost to the Society of upwards of £60.

Another item of expenditure which had arisen during his tenure of office is connected with the lectures which are given in memory of the deceased Foreign Members. The Society has now a collection of eight of these Memorial Lectures, all of which have been given gratuitously by Fellows or friends on the invitation of the Council. Their publication has cost about £400. These lectures together constitute a most valuable record of contemporary chemical history, and it is hoped that, as the

Council have directed, they may be issued in a separate volume, with the accompanying illustrations, before the end of the next financial year.

In their donations to funds connected with the illustrious names of Lavoisier, Davy, Stas, Kekulé, Cannizzaro, the Fellows have not been unmindful of their obligations to these great pioneers in chemical enquiry, nor have they been forgetful, as the gathering of last November showed, of their obligations to the pioneers in their own Society happily still amongst us.

The Account books of the Society show that what he had called the extraordinary expenditure which has been incurred during the last ten years is close upon £7000.

He thought, however, they would all feel that, in the enhanced position of their Society, in the greater comfort and convenience of their Meeting Room, in the improvement and increased value of their publications, they had had an abundant return for this expenditure. Although but for it he might have been able to add a few more thousand pounds to their capital account. He hoped the Fellows would not hold him responsible for this omission, but look with a lenient eye upon the financial transgressions of what he sometimes felt himself to have been—a too compliant purse-bearer.

Mr. DAVID HOWARD proposed that the thanks of the Fellows be tendered to the Treasurer for his services during the past year; this motion was seconded by Mr. F. J. M. PAGE, and carried.

The TREASURER, in responding, proposed a vote of thanks to the auditors.

Prof. HODGKINSON seconded the motion, which was unanimously adopted, and acknowledged by Prof. TILDEN on behalf of Dr. HORACE BROWN.

Dr. E. W. VOELCKER proposed a vote of thanks to the Officers and Council.

Mr. H. B. BAKER seconded the motion, which was unanimously adopted.

Prof. DUNSTAN, F.R.S., responded on behalf of the Council.

Prof. THOMSON, F.R.S., proposed a vote of thanks to the Editor, Sub-Editor, Abstractors, and Indexers, which was seconded by Dr. MESSEL and carried.

Mr. GROVES, F.R.S., responded.

The Scrutators having presented their report to the President, he declared that the following had been duly elected:—

President: T. E. Thorpe, Ph.D., D.Sc., LL.D., F.R.S.

Vice-Presidents who have filled the office of President: Sir F. A. Abel, Bart., K.C.B., D.C.L., F.R.S.; H. E. Armstrong, Ph.D., LL.D., F.R.S.;

A. Crum Brown, D.Sc., LL.D., F.R.S.; Sir W. Crookes, F.R.S.; James Dewar, M.A., LL.D., F.R.S.; Sir E. Frankland, K.C.B., D.C.L., F.R.S.; Sir J. H. Gilbert, Ph.D., LL.D., F.R.S.; J. H. Gladstone, Ph.D., D.Sc., F.R.S.; A. Vernon Harcourt, M.A., D.C.L., F.R.S.; H. Müller, Ph.D., LL.D., F.R.S.; W. Odling, M.B., F.R.S.; W. H. Perkin, LL.D., Ph.D., F.R.S.; Sir H. E. Roscoe, LL.D., F.R.S.; W. J. Russell, Ph.D., V.P.R.S.; A. W. Williamson, LL.D., F.R.S.

Vice-Presidents: C. E. Groves, F.R.S.; G. D. Liveing, M.A., D.Sc., F.R.S.; T. Purdie, Ph.D., F.R.S.; William Ramsay, Ph.D., LL.D., F.R.S.; J. Emerson Reynolds, M.D., D.Sc., F.R.S.; John M. Thomson, F.R.S.

Secretaries: Wyndham R. Dunstan, M.A., F.R.S.; A. Scott, M.A., D.Sc., F.R.S.

Foreign Secretary: Raphael Meldola, F.R.S.

Treasurer: William A. Tilden, D.Sc., F.R.S.

Other Members of Council: H. Brereton Baker, M.A.; E. J. Bevan; Frank Clowes, D.Sc.; H. J. H. Fenton, M.A.; W. Gowland; C. T. Heycock, M.A., F.R.S.; D. Howard; Rudolph Messel, Ph.D.; G. T. Moody, D.Sc.; H. Forster Morley, M.A., D.Sc.; Arthur Smithells, B.Sc.; James Walker, D.Sc.

At the next ordinary meeting, on Thursday, April 20th, the following papers will be communicated:—

“Some dipyrindyl derivatives from citrazinic acid.” By W. J. Sell, M.A., and H. Jackson, B.A., B.Sc.

“The synthesis and preparation of terebic and terpenylic acids.” By W. Trevor Lawrence.

“The allotropic modifications of phosphorus.” By D. L. Chapman.

“ β -Isopropyl glutaric acid.” By F. H. Howles, and J. F. Thorpe.

“Ethyl ammonium sulphite.” By Edward Divers and Masataka Ogawa.

“Ethyl ammonium selenite and non-existence of amidoselenites (selenosamates).” By Edward Divers and Seihachi Hada.

CERTIFICATES OF CANDIDATES FOR ELECTION AT THE NEXT BALLOT.

N.B.—The names of those who sign from “General Knowledge” are printed in *italics*.

The following Candidates have been proposed for election. A ballot will be held on Thursday, May 4th.

Allworthy, James Herbert,
Laxton School, Oundle.

Schoolmaster. Eight years' experience as a teacher of Practical Chemistry. Practical work at University Tutorial College, and Theoretical work in connection with University Correspondence College.

Alfred J. Wilcox.

Willie Briggs.

H. O. Hale.

George Ryce.

W. J. Lewis.

Auchinachie, Peter,
12, Mid Street, Keith, N.B., *pro. tem.*; 70, Newman Street,
Oxford Street, W.

Analytical Chemist. Have passed the Minor and Major Examinations of the Pharmaceutical Society of Great Britain, the subjects being Elementary and Advanced Chemistry (Organic and Inorganic), Materia Medica, Botany, and Physics. Have served as assistant under Mr. C. H. Cribb, B.Sc., F.I.C., F.C.S., Public Analyst to the Strand District, for 2 years. I am now in Analytical practice on my own account.

Cecil H. Cribb.

M. Carteighe.

George T. Holloway.

John Wilson.

Percy F. Frankland.

Charles J. S. Makin.

Baker, Clement Harrison,

Athelney, Featherstone Road, King's Heath, Birmingham.

Assayer and Refiner. Assayer and Refiner to Messrs. Charles

Harrold and Co., assayers, bullion dealers and refiners, St. Paul's Square, Birmingham. Assayer to The Mint, Birmingham, Ltd.

Chas. Bayliss.

Thomas J. Underhill.

H. S. Shorthouse.

W. J. Lancaster.

Colin Gordon.

Beale, Frederick James,

Wilderspool Brewery, Warrington.

Assistant Brewer and Analyst to Messrs. Greenall, Whitley & Co., Limited, Wilderspool. Studied General Chemistry 10 years under Dr. Cook, F.I.C., F.C.S., Dr. Leicester, F.I.C., F.C.S. One year Technical Brewing Chemistry under J. Heron, Esq., F.I.C., F.C.S., and hold an Advanced Certificate for Practical Inorganic Chemistry, Science and Art Department.

Ernest H. Cook.

W. B. Roberts.

James Leicester.

Alex. R. Miller.

Fred. R. Stone.

Belton, Frank,

103, Lower Seedley Road, Pendleton, Manchester.

Lecturer in Chemistry in the School of Science, Central Higher Grade Scholarship School, Salford, for 5 years. I. First Class, Advanced Stage, in the Examinations of the S. and A. Dept., South Kensington, in Inorganic Chemistry (Theoretical and Practical). II. The Pass Examination in Chemistry for the London Final B.Sc.

W. B. Hards.

R. L. Taylor.

Edgar E. Horwill.

Chas. T. F. Watts.

Duncan T. Richards.

Bond, Alfred Ernest,

Princes Chambers, Corporation Street, Birmingham.

Iron and Steel Trade and Analytical work connected therewith. Six years' Laboratory work (3 years in Private Laboratory and 3 years in Chemical and Metallurgical Laboratories [at Mason University College]); at present Analyst for Messrs. J. C. Abbot and Co.

Percy F. Frankland.

W. R. Innes.

Godfrey Melland.

C. F. Baker.

Andrew Turnbull.

Bratby, George Smith,

Oak Field, Hale, Bowdon, Cheshire.

Manufacturing Chemist. Student for 4 years in the Chemical Dept. of the Owens College.

H. B. Dixon.

D. S. Jerdan.

W. H. Perkin, jun.

W. T. Lawrence.

William A. Bone.

Browning, Kendall Colin,

St. John's College, Cambridge.

B.A. (Camb.). Assistant Demonstrator at St. John's College, Cambridge. First Class Natural Science Tripos, Parts I. and II., joint author (with Dr. Ruhemann) of the following papers :— "On the Formation of Ethylic Dihydroxydinicotinate" (*Trans. Chem. Soc.*, **73**, 280, 1898), "Additive Compounds of Organic Bases and Unsaturated Esters" (*Trans. Chem. Soc.*, **73**, 723, 1898), "On Formation of β -Ketonic Esters" (*Trans. Chem. Soc.*, **73**, 727, 1898).

H. Brereton Baker.

F. W. Dootson.

S. Ruhemann.

W. T. N. Spivey.

R. Haliburton Adie.

M. M. Pattison Muir.

Collingridge, William,

Port Sanitary Office, Greenwich, S.E.

Medical Officer of Health, Port of London. M.A., Honours Natural Science Tripos, M.D., LL.M., D.P.H., Cambridge. Have been for many years engaged in chemical and bacteriological examination of water, food, &c., in connection with duties as M.O.H. Port., and take a general interest in chemical science in its relation to medicine and public health, specially with regard to adulteration legislation.

W. H. Corfield.

W. H. Symons.

A. Wynter Blyth.

R. J. Friswell.

Christopher Childs.

W. J. Russell.

John Muter.

Henry E. Armstrong.

Connell, Robert D.,

38, Chapel Road, Stamford Hill, N.

Analytical Chemist. For eighteen months assistant to T. Fairley, Esq., F.R.S.E., F.I.C., F.C.S., Borough Analyst for Leeds. For two years assistant to E. Riley, Esq., F.I.C., F.C.S., Analyst and Assayer, London. Six months Chief Chemist at the Iron Mines of Elba, Italy, and now Chief Chemist to the firm of W. H. Pearson and Co., analysts and mineral samplers, London. Hold First Class Honours Certificate in Practical Inorganic Chemistry, and also Certificate for Organic Chemistry and Metallurgy from the Science and Art Department.

Thomas Fairley.

B. A. Burrell.

Edw. Riley.

James E. Ferguson.

W. H. Pearson.

Darling, Charles Robert,†

12, Nithdale Road, Plumstead, S.E.

Instructor in Chemistry and Physics, Royal Military Academy,

Woolwich. Royal Exhibitioner and Associate Royal College of Science, Dublin. Whitworth Exhibitioner. Sometime Assistant Chemist to the London and North-Western Railway Company, Crewe.

W. R. Hopkinson.

Alexander Scott.

W. N. Hartley.

Frederic Jas. M. Page.

Hugh Ramage.

Leonard Temple Thorne.

A. J. Greenaway.

Goltz, Harold Francis Carl,

7, Craster Road, Upper Tulse Hill, S.W.

Student. Have been studying Chemistry at the Birkbeck Literary and Scientific Institution since 1894. I intend to become an Analytical Chemist, and am also working for the B.Sc. degree.

John E. Mackenzie.

Geo. Stubbs.

J. Woodward.

Chas. J. Meads.

Edwd. Jones.

Frank Gossling.

Haigh, Percy,

312, Romford Road, Forest Gate, E.

Analytical Chemist. Served the usual professional pupilage to C. Estcourt, Manchester. Chemist to Messrs. Dickens, Pease & Co. Science and Art Examinations. Four First Certificates in Science Subjects. City Guilds Silver Medallist. Cambridge Local Examinations. One First Certificate.

C. Estcourt.

J. A. Williamson.

W. Hepworth Collins.

H. Bailey.

Jas. Gardner.

J. Carter Bell.

Horatio Ballantyne.

Edward Bevan.

Hughes, John Elias,

Birchville, Wrexham.

Technical Chemist. Have for several years held the position of Chemist to one of the largest leather manufacturing firms in England. Am a member of the "International Association of Leather Trades Chemists," and have for some years acted as a Teacher of Chemistry.

Alfred Neobard Palmer.

Robert Hellon.

Henry R. Procter.

Arthur Smithells.

Herbert Ingle.

Hunter, Archibald Glen Kidston,

Dunedin, New Zealand.

Public Analyst. Analytical Consulting Chemist to Dunedin City Corporation. Lecturer on Chemistry, Technical Schools. Chemist to

Customs Agricultural Government Departments at Dunedin, New Zealand.

Henry de Mosenthal.

Arthur R. Ling.

Otto Hehner.

B. E. R. Newlands.

Oscar Guttman.

A. Wynter Blyth.

Wyndham R. Dunstan.

Jones, Lauder William,

University of Chicago, Chicago, Ill., U.S.A.

A.B. Williams College, 1892. Fellow in Chemistry, University of Chicago, 1895—7. Ph.D. University of Chicago, 1897. Assistant in Chemistry, *ibid.*, 1897 to date. Publications:—"On Salts of Nitro-paraffins and Acylated Derivatives of Hydroxylamine," *American Chemical Journal*, 20, No. 1.

Albert B. Prescott.

Alexander Smith.

J. Bishop Tingle.

James Walker.

Otis C. Johnson.

Judge, Thomas.

142, Waller Road, New Cross, S.E.

Science Master. B.A. St. John's College, Oxford, with First Class Honours in the School of Natural Science (Chemistry). For nearly two years Science Master of Aske's Hatcham School, New Cross, S.E.

Percy Elford.

V. H. Voley.

W. Odling.

E. G. J. Hartley.

W. W. Fisher.

William E. Moss.

D. H. Nagel.

H. L. Bowman.

H. A. Miers.

Lindsey, Robert William,

22, Hilldrop Crescent, Camden Road, N.

Chemical Manufacturer. Pupil at University College under Professor Ramsay in 1890—1. Student in Analytical and Theoretical Chemistry under Mr. T. A. Ellwood, F.I.C., Mr. W. Watson Will, F.C.S., and Mr. F. A. Hocking, B.Sc. At present engaged in chemical manufacture.

T. A. Ellwood.

Harry Garnett.

William Ramsay.

W. Watson Will.

Rudolph Messel.

MacLeod, James,

Westhill, Cardross Road, Dumbarton.

Analytical Chemist. Studied Chemistry with Messrs. Wallace, Tatlock, and Clark for two years. Acted as Laboratory Assistant to Dr. Clark for two years. For eight years Chemist to the Glasgow

Corporation's Gas Works, Dalmarnock. Contributed paper on "Photometry" to City Analysts' Society, Glasgow.

John Clark.

Horatio Ballantyne.

R. R. Tatlock.

G. G. Henderson.

Thomas Gray.

J. A. Williamson.

McConnell, William,

178, Springfield Road, Glasgow.

Practical Dyer and Chemist. I have had a two years' course of Chemistry in the Glasgow Technical College, and am Chemist and practical Dyer here. I have lectured in the Glasgow Weaving College and at Kilmarnock on dyeing. I have been appointed instructor of a dyeing class now started in the Glasgow Weaving College.

G. G. Henderson.

Matthew A. Parker.

James Robson.

Thomas Gray.

A. Humboldt Sexton.

Morris, Wilfred Walter,

Newtown-St. Boswells, Roxburghshire, N.B.

Assistant (Office and Laboratory) to the Medical Officer of Health for the counties of Roxburghshire and Selkirkshire, and Burgh of Melrose. Eight Certificates in Science from Science and Art Department, South Kensington, including 1st Class (Queen's Prize), Advanced Theoretical Chemistry; 2nd Class Advanced Practical Chemistry, and 1st Class Advanced Hygiene. Have worked for some time in the Laboratory of Mr. M. Dechan, F.I.C., F.C.S., Public Analyst, Hawick. Have contributed papers to the *Sanitary Journal* on "Pollution of Rivers" and "Water Supplies." Lectured on the Chemistry of the Air, &c., and other public health matters. Am generally interested in the application of Chemical Science to Public Health work.

M. Dechan.

Harold Rostron.

E. Haworth.

Charles A. Fogg.

Jno. L. Whiteside.

Panting, Laurence Christopher,

9, Beverley Road, Anerley, S.E.

Demonstrator of Chemistry and Physics at Guy's Hospital. B.A., M.B., B.Ch., Oxon, M.R.C.P., London. Scholar of Balliol College, Oxford. Honours in Final School in Chemistry. Joint author of "Preparation of Hydrogen Cyanide and Carbon Monoxide," *Trans.*, 73, 255, 1898.

Thos. Stevenson.

D. H. Nagel.

Charles E. Groves.

A. Vernon Harcourt.

John Conroy.

John Wade.

Pittuck, Frederick Williams,

19, Stratford Grove, Newcastle-on-Tyne.

Manufacturing Chemist, with considerable experience in the manufacture of barium salts, purification of copper, and extraction of silver therefrom, arsenic, &c., and for several years engaged in commercial analysis (slags, clays, cements, &c.), also assaying lead, silver, and gold.

Thomas Tyrer.

Frederick Gilderdale.

J. Fleming Stark.

Geo. F. Merson.

A. Garden Hendry.

J. Wilson Swan.

Read, Harold McLean,

127, Warwick Road, Earls' Court, S.W.

Assistant Chemist in the Research Laboratory of the Imperial Institute. Student in the Pharmaceutical Society's School, 1894—1895. Student in the Pharmaceutical Society's Research Laboratory, 1895—1896.

Wyndham R. Dunstan.

H. A. D. Jowett.

J. T. Dunn.

R. L. Jenks.

Ernest Goulding.

Schryver, Samuel Barnett, D.Sc. (Lond.), Ph.D. (Leipzig),

27, Arundel Gardens, W.

Chemist. Author of "Researches on Oxidation Products of Turpentine Oil," "Researches on Camphoric Acid," and other papers published by the Society.

Frederick B. Power.

W. Palmer Wynne.

H. A. D. Jowett.

M. O. Forster.

William Ramsay.

Schweich, Maurice Emile,

85, Belgrave Road, S.W.

Technical Chemist. Student of Chemistry for five years at the Polytechnical School, Zurich, where obtained Diploma for Chemistry, and has been ever since engaged in manufacturing Chemistry.

Ludwig Mond.

Joseph W. Swan.

James Dewar.

Thomas Tyrer.

Alfred Gordon Salamon.

Shelbourn, Edward Thomas,

1, Chalcot Crescent, Regent's Park Road, and 40, Craven Street, Strand.

Assistant Analyst in L.C.C. Laboratory. Four years' course in Chemistry at University College, Nottingham. Assistant three

years to Dr. A. Hill, City Analyst, Birmingham. Associate of the Institute of Chemistry since 1894. Now F.I.C.

Frank Clowes.	J. H. Coste.
Alfred Hill.	A. Hunter Boylan.
J. Bernard Coleman.	E. Brooke Pike.
R. Grimwood.	R. Bodmer.
Ernest J. Parry.	J. Wade.

Shelton, Arthur John,

19, Sturry Street, Poplar, E.

Chemist to Messrs. Fowler, Ltd., Sugar Refiners, Blackwall. Associate of the City Guilds Institute (1896). Late Assistant to John Heron, F.I.C., F.C.S.

Henry E. Armstrong.	Gerald T. Moody.
John Heron.	A. Lapworth.
Sidney Williamson.	W. Palmer Wynne.

Thiersch, Harry Alexander,

8, Clifton Gardens, London, W.

Analytical Chemist. Educated at Wiesbaden and Berne. Studied Chemistry at King's College, London, during the Sessions 1897—1898. Since November, 1898, with Dr. Dupré, F.R.S.

John M. Thomson.	A. Dupré.
Herbert Jackson.	Patrick H. Kirkaldy.
Leonard M. Nash.	S. Dickson.

Thomson, Robert Tatlock,

156, Bath Street, Glasgow.

Analytical Chemist and Public Analyst. Author of various articles on "Indicators in Volumetric Analysis," *Chemical News*, 1883, 1884, and 1885; and *Journal of Society of Chemical Industry*, 1887 and 1893; "On the Analysis of Oils and Fats" *Jour. Soc. Chem. Ind.*, 1890, 1891, and 1892; "On Water for Dietetic Purposes," *J.S.C.I.*, 1894; "On Boric Acid in Foods," *J.S.C.I.*, 1895; "Formic Aldehyde as a Preservative," *Chem. News*, 1895, &c.

R. R. Tatlock.	William Ramsay.
Alex. Crum Brown.	Edmund J. Mills.

Alfred H. Allen.

Threlfall, Richard,

45, Frederick Road, Edgbaston, Birmingham.

Scientific Director to Messrs. Albright & Wilson, Ltd., Oldbury. Late Professor of Physics, University of Sydney, N.S.W. Papers on Physico-Chemical matters: amongst others, "On the Electric Proper-

ties of Pure Sulphur," *Phil. Trans.*, 1897; "On the Measurement of High Specific Resistances," *Phil. Mag.*, 1886—1889; "On Electric Discharge in Purified Gases," *Phil. Proc.*, 1886, and *Phil. Mag.*, 1891 (?); "On Losses of Energy in Cycles of Electrification of Purified Substances," *Physical Review*, 1897. Books: *Report of N.S.W. Royal Commission on Spontaneous Heating of Coal*, of which the candidate was President. *Handbook of Spontaneous Heating of Coal Cargoes*. N.S.W. Government Publication. *Laboratory Arts*, Macmillan. 1898.

Henry E. Armstrong.

M. M. Pattison Muir.

William A. Tilden.

Alexander Scott.

Geo. S. Albright.

Tyler, Ernest Albert,

Warsop, Mansfield, Notts.

Science Master, Devon County School, South Molton. B.A., Cambridge. Late Science Scholar, St. John's College, Cambridge, Worked conjointly with Dr. Ruhemann on "Ethylic Acetoacetates," published in the Transactions of the Chemical Society, 1896.

S. Ruhemann.

M. M. Pattison Muir.

R. H. Adie.

Sidney Skinner.

F. H. Neville.

Wade, Arthur Luvian,

28, West Kensington Gardens, W.

Analytical Chemist. Three years a student with the late Professor R. Fresenius at Wiesbaden. Two years assistant to Martin Dechan, Esq., F.I.C., Public Analyst, Hawick, N.B.

B. E. R. Newlands.

Henry Bailey.

Arthur R. Ling.

Oscar Guttmann.

Otto Hehner.

Henry de Mosenthal.

Thomas Royle.

Walden, Allan Frederick,

New College, Oxford.

(M.A. Oxon.) Lecturer in Chemistry in New College. Demonstrator in the Balliol College Laboratory. First Class, Final Honour School (Chemistry), 1895.

William Odling.

D. H. Nagel.

W. W. Fisher.

P. Elford.

John Watts.

J. E. Marsh.

Walker, Charles,

Care of T. B. Walker, Scott Chambers, Pitt St., Sydney,
N.S.W.

Metallurgical Chemist and Assayer. Three years a Student in the

Chemical, Metallurgical, and Geological Laboratories of the University of Sydney, N.S.W. Two years Geological Assistant to the Mount Morgan Gold M. Co., Ltd., Queensland. Six months Junior Demonstrator of Chemistry, University of Sydney.

A. Liversidge.

F. W. Guthrie.

J. A. Schofield.

Wm. A. Dixon.

William M. Hamlet.

Watson, Fred Sheasby,
Springside, Disley, Cheshire.

Senior Assistant Science Master at the High Pavement, Stanley Road Board Higher Grade School, Nottingham. B.Sc. (Hons. Vict.) in Chemistry. Was for four years a Student in the Honours School of Chemistry at the Owens College, Manchester.

H. B. Dixon.

G. H. Bailey.

W. H. Perkin, jun.

A. William Gilbody.

W. T. Lawrence.

William A. Bone.

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April 20th, 1899. Professor Thorpe, F.R.S., President, in the Chair.

Messrs. A. J. While, W. J. Sell, and S. Godfrey Hall were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. Robert Henry Aders, 28, St. John's Wood Road, N.W.; Percy Bean, 42, Granville Road, Blackburn; Walter Lionel Blackman, Mostyn, Mount Nod Road, Streatham, S.W.; Wilfred Carpmael, 24, Southampton Buildings, Chancery Lane, W.C.; Frederick Doyle, 8 Woodlands Terrace, Middlesbrough; Frederick Charles Duncombe, 54, Woodstock Road, Bristol; William Frederick Eichenauer, 58A, Maryon Road, Old Charlton, Kent; Friedrich Noel Ashcroft Fleischmann, Magdalen College, Oxford; Frederick Hutton Getman, 196, Atlantic Street, Stamford, Conn., U.S.A.; Julius Hübner, 24, Delanney's Road, Crumpsall, Manchester; Edward Charles Johnson, Lithgow, N.S.W., Australia; Arthur Alexander Leon, 13, Cleveland Square, Hyde Park, W.; James McAlley, Bankside, Falkirk; George Alfred Parkes, Muckamore Bleach Works, co. Antrim, Ireland; Stanley John Peachey, 48, Grange Road, S.E.; Sidney Rossiter, 19, Ranelagh Road, West Green, N.; William Frederick John Shephard, 12, Bridge Street Row, Chester; John Ward Stainer, 103, Cheriton Road, Folkestone; George Hardstaff West, Frankwell, Llanidloes.

The following Certificate was authorised by the Council under Bye-law I (3).

Bennetts, Benjamin Harvey,

Gormanston, Mt. Lyell, Tasmania.

Assayer. Two years Student at the School of Mines, Ballarat

Victoria. At present Assayer for the Mount Lyell Mining and Railway Company, Tasmania.

Albert H. Turton.

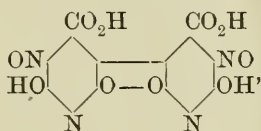
Harold Harris.

John Provis.

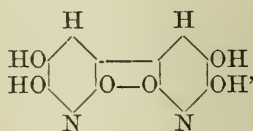
Of the following papers, those marked * were read :—

- *48. "The synthesis of some $\beta\beta'$ -dipyridyl derivatives from citrazinic acid." By W. J. Sell, M.A., and H. Jackson, B.A., B.Sc.

The present communication deals mainly with the constitution of some of the compounds described by Sell and Easterfield (*Trans.*, 1893, 63, 1035), of which little more than an analysis and brief description were given. It is now shown that citrazinic acid yields a nitroso-derivative, to which the formula $\text{CO}_2\text{HC} \begin{array}{c} \text{CH}_2-\text{CO} \\ \text{CNO}-\text{C}(\text{OH}) \end{array} \text{N}$ may be assigned. This compound is readily oxidised by nitrous or nitric acids, producing the yellow acid represented by formula I,



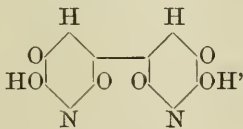
I.



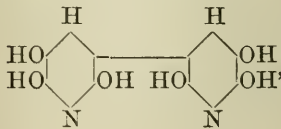
II.

both these substances, on reduction, readily yield a very sparingly soluble compound having a bronze-like appearance, and possessing the constitution represented by formula II.

The bronze-like substance reacts readily when boiled with fuming hydriodic acid and phosphorus, producing *aa'*-diglutaric acid, thus showing that these substances are derivatives of dipyridyl. With nitric acid, it produces a golden-yellow, crystalline compound, to which the authors assign the constitution represented by formula III,



III.



IV.

This substance is readily reduced to the bronze-like compound, and further reduction, either by hydriodic acid or stannous chloride, produces the hexahydroxy-derivative having the constitution represented by formula IV.

If the bronze-like substance be heated at 100° with chlorosulphonic acid, a white, crystalline compound, having the formula $\text{C}_{10}\text{H}_4\text{Cl}_2\text{O}_3$, is produced.

*49. "Action of hydrogen peroxide on carbohydrates in the presence of iron." By R. S. Morrell, M.A., Ph.D., and J. M. Crofts, B.A., B.Sc.

Cross and Bevan, in their paper on the reaction of carbohydrates with hydrogen peroxide (*Trans.*, 1898, 73, 463), showed that substances which reacted with phenylhydrazine in the cold were formed. In September, 1898, some results of the reaction were communicated to the British Association, in which it was shown that the first product was undoubtedly glucoson. The glucoson had not then been isolated, but was identified by means of the osazone formed by the action of phenylhydrazine *in the cold*, and by the isolation of the methyl phenyl glucosazone, precipitated also in the cold. The formation of this methyl phenyl glucosazone was considered by Fischer to be one of the characteristic tests for the presence of glucoson.

The action of hydrogen peroxide in the presence of ferrous salts has been extended to levulose and galactose, to the pentose arabinose, and to the methyl pentose, rhamnose. Of these, levulose and arabinose have yielded results which are similar to those obtained with glucose, namely, the formation of an oson.

The oson was detected, in the case of glucose, by the formation, in each instance in the cold, of phenyl glucosazone (m. p. 205°), and of methyl phenyl glucosazone (m. p. 152°), both the glucosazones being analysed. The solution of the glucoson reduces Fehling's solution in the cold, and more strongly so on slightly warming. It yields precipitates in the cold with diamines, with hydrazine, and with substituted hydrazines.

It might be that the osazones were formed from the glucose directly, and not from the oson; the solution, however, after fermentation at 30°, was still found to react quite as readily with hydrazines in the cold. A small quantity of the oson isolated was found to have properties like those ascribed by Fischer to glucoson.

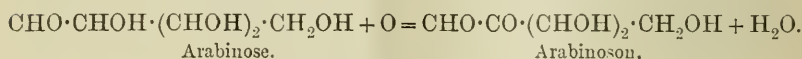
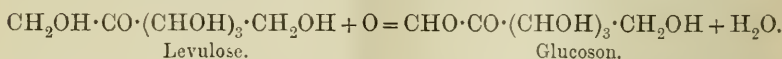
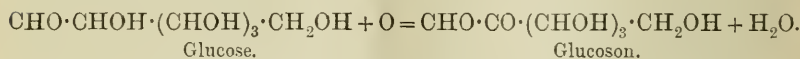
The behaviour of levulose is almost identical with that of glucose under like conditions of treatment. The oson formed is glucoson, and its identification rests on the same evidence as that given for glucoson from glucose.

With regard to arabinose, the action is again similar to that which takes place in the case of the hexoses. Arabinoson is undoubtedly formed, and its identification is established by the formation of arabinosazone in the cold, and more completely by the formation of methyl phenyl arabinosazone in the cold, whereas arabinose and methyl phenyl hydrazine, even with excess of the hydrazine and after warming on the water-bath, were found to form methyl phenyl arabinose hydrazone.

Galactose and rhamnose, under like conditions of treatment, also form substances of the nature of an oson, which are being investigated.

The action of bromine at 40° on the solution of the glucoson gives a liquid still strongly reducing, which reacts easily with phenylhydrazine, and forms, in the case of levulose, a soluble calcium salt of a dibasic acid, which is probably an oxysaccharic acid.

The course of the reactions may, perhaps, be expressed by the following equations.



DISCUSSION.

Mr. FENTON said that he was very glad that Dr. Morrell had succeeded in bringing his observations on carbohydrates to the present stage. His results now nearly completed the series of investigations which had been undertaken with a view of studying the behaviour of typical hydroxy-compounds towards oxidising agents in presence of iron.

*50. "The condensation of oxalic acid and resorcinol." By John Theodore Hewitt and Arthur Ernest Pitt.

The condensation of oxalic acid and resorcinol, on heating with concentrated sulphuric acid, has been studied by von Baeyer (*Ber.*, 1871, 4, 662) and Gukassianz (*Ber.*, 1878, 11, 1184). The former stated that the product obtained closely resembled euxanthone, the latter that two isomeric substances were formed, both having the formula $\text{C}_{14}\text{H}_8\text{O}_5$, but whilst one was soluble in alcohol and gave non-fluorescent alkaline solutions, the other was insoluble in alcohol, but dissolved in alkalis with a fine, moss-green fluorescence.

The authors have studied the former of these two products, which is the chief product of the reaction. It is distinct from the substances obtained by Claus and Andreae (*Ber.*, 1877, 10, 1305; 1881, 14, 2563) and von Georgievics (*Mitt. technol. Gewerb.-Mus. Wien*, 1898, [ii], 8, 364). These chemists used an excess of oxalic acid as a condensing agent, and employed a higher temperature. Gukassianz misinterpreted the results obtained on combustion; his compound really has the formula $\text{C}_{20}\text{H}_{14}\text{O}_7$, and is probably a carboxylic acid. In addition to further analyses of this compound, the authors describe the following derivatives.

Sodium and lead salts, $\text{C}_{20}\text{H}_{13}\text{O}_7\text{Na}$, $(\text{C}_{20}\text{H}_{13}\text{O}_7)_2\text{Pb}$. Triacetylated lactone, $\text{C}_{20}\text{H}_9\text{O}_6(\text{C}_2\text{H}_3\text{O})_3$. Triacetylated acid, $\text{C}_{20}\text{H}_{11}\text{O}_7(\text{C}_2\text{H}_3\text{O})_3$.

Tetracetylated lactone of leuko-acid, $C_{20}H_{10}O_6(C_2H_3O)_4$. Product obtained from acid and benzoyl chloride, (?) $C_{14}H_7O_5(C_6H_5CO)$. Dinitro-lactone, $C_{20}H_{10}(NO_2)_2O_6$. Sodium salt of dinitro-acid, $C_{20}H_{11}(NO_2)_2O_7Na$. Triacetylated dinitro-lactone, $C_{20}H_7(NO_2)_2O_6(C_2H_3O)_3$. Tetrabrominated acid, $C_{20}H_{10}Br_4O_7$.

From the composition of the compounds described, the authors consider that the acid must be represented by the formula $[C_{18}H_9(:O)(OH)_4]:C \cdot CO_2H$.

51. "Ethyl ammonium sulphite." By Edward Divers and Masataka Ogawa.

Dissolved in alcohol, sulphur dioxide and ammonia combine with each other and the alcohol to form a new salt, ethyl ammonium-sulphite, which is a crystalline solid, subliming undecomposed in dry air, soluble in alcohol, insoluble in ether, and at once changed by water into alcohol and ammonium pyrosulphite. Hence, in preparing the salt, the absence of water must be carefully secured. Ethyl ammoniumsulphite belongs to the series of new sulphites, or metal-sulphonates discovered within the last few years:—Phenyl sodium-sulphite (Schall, 1892); methyl magnesiumsulphite (Szarvasy, 1897); methyl and ethyl sodiumsulphites and ethyl potassiumsulphite (Rosenheim and Liebknecht, 1898), which are distinguished from alkylsulphonates in at once decomposing with water into phenol or alcohol and pyrosulphite, and in being formed by the union of sulphur dioxide with metal alkoxide or ammonium alkoxide. Warlitz's potassium ethyl sulphite has been shown by Rosenheim and Liebknecht to be only potassium ethylsulphonate. The new salts are not decomposed by excess of sulphur dioxide; Rosenheim and Liebknecht, who found that they were, must have allowed moisture to enter their vessels.

52. "Ethyl ammonium selenite and non-existence of amidoselenites (selenosamates)." By Edward Divers and Seihachi Hada.

Selenium dioxide and ammonia, dissolved together in well-cooled alcohol, in the absence of any water, form a new salt, ethyl ammonium selenite, soluble in alcohol, insoluble in ether, and at once decomposed by water into acid ammonium selenite and alcohol. The salt soon begins to decompose at the common temperature, selenium being one of the products. Hinsberg obtained, in 1890, what appears to have been ethyl hydrogen selenite and ethyl phenylammonium selenite.

When water is also present, the ammonia and selenium dioxide do not unite with the alcohol, but with the water to form the ammonium

selenites, a fact known to Berzelius. Cameron and Macallan (1888), proceeding apparently in the way the authors have prepared ethyl ammonium selenite, obtained instead salts which they describe as being selenosamates. But Cameron and Macallan record no property of their selenosamates which can serve to distinguish them from the half-acid and three-fourths-acid ammonium selenites, except their chemical composition, which was determined by methods of doubtful accuracy. The authors, therefore, believe that Cameron and Macallan cannot have taken sufficient precautions to exclude all moisture in their experiments, and conclude that there is no reliable evidence for the existence of amidoselenites. Accordingly, selenious acid seems to form no compounds analogous to amido-, imido-, or nitrilo-sulphates, any more than it forms salts like alkylsulphonates or salts having the constitution of metal sulphites.

Incidentally, the authors obtained, in the pure state, normal ammonium selenite, half-acid ammonium selenite, and three-fourths-acid ammonium selenite.

53. "The allotropic modifications of phosphorus."

By D. L. Chapman, B.A.

From experiments performed by the author, the following conclusions have been drawn.

(1.) "Metallic" and red phosphorus are identical. This is proved by their similarity in appearance when viewed under the microscope. The alleged higher vapour tension of some varieties of red phosphorus is due to impurity, which on heating decomposes with formation of phosphorus vapour.

(2.) The vapours of red and ordinary phosphorus are identical. The vapour density of ordinary phosphorus has been determined at the boiling points of mercury and of sulphur, and agrees closely with the density calculated on the assumption that the molecule consists of four atoms, although the results obtained by Mitscherlich and by Deville and Troost at higher temperatures would scarcely lead one to suspect that this would be the case.

(3.) Red phosphorus melts, forming ordinary phosphorus, under pressure at the melting point of potassium iodide. This point on the pressure temperature diagram the author proposes to call the triple point of red phosphorus. Melted ordinary phosphorus thus becomes superfused red phosphorus, and superfused ordinary phosphorus becomes the superfused liquid of both varieties. At ordinary temperatures, red phosphorus is stable and white phosphorus unstable. Phosphorus, therefore, appears to possess in a remarkable degree the property of remaining in an unstable condition.

54. "On the interaction of mercurous and mercuric nitrites with the nitrites of silver and sodium." By P. C. Rây, D.Sc.

(1.) *Mercuric and sodium nitrites.* To the neutral solution of mercurous and mercuric nitrites, the products of the dissociation of mercurous nitrite (*Trans*, 1897, 71, 340), sodium chloride is added to remove mercurous salts. The filtrate containing mercuric and sodium nitrites, and possibly a small quantity of sodium chloride, is allowed to evaporate spontaneously. In course of time, an orange-red, crystalline deposit is formed, followed by iodine-like scales, and finally crystals of sodium nitrate. Sometimes sodium nitrate is the only substance obtained. Unless sodium chloride is present, the coloured compounds are not formed. Analysis seems to show that the formula of the coloured substances is $\text{HgCl}_2 \cdot 2\text{HgO} \cdot \frac{1}{2}\text{H}_2\text{O}$, but they lose no weight in a desiccator over sulphuric acid nor when kept at 100° , but if heated in a bulb tube a deposit of moisture is invariably noticed. Millon, Thummel, Volhard, and Haack have described very similar compounds with the formula $\text{HgCl}_2 \cdot 2\text{HgO}$, but no mention is made of any hydrated modification.

(2.) *Mercurous and silver nitrites.* To a hot solution of mercurous nitrite (containing mercuric nitrite) solution of silver nitrite was added. There was no effervescence, but the liquid at once became cloudy, and was allowed to stand overnight. Next day a clear solution was obtained, having at the bottom a layer of dirty grey mercury, and above it a deposit of shining, minute crystals of silver.

Careful analyses showed that, not only was there no loss of nitrogen during the reaction, but that it remained entirely in the form of nitrite.

With dilute solutions no silver was precipitated. In the reaction between mercurous and sodium nitrites, the nitrogen remained as nitrite, the mercurous nitrite decomposing entirely into mercuric nitrite and mercury.

The true explanation of the reactions has yet to be found, and with this end in view the author intends to make further experiments with solutions of the nitrites in varying degrees of dilution.

55. " β -Isopropylglutaric acid." By F. H. Howles and Jocelyn F. Thorpe.

β -Isopropylglutaric acid was originally prepared by Schryver, by the reduction of terpenylic acid and synthesised by him in small quantities by the action of ethylic sodiomalonate on ethylic isobutylenemalonate (*Trans*., 1893, 1345); later, Knoevenagel (*Ber.*, 1898, 31, 2585) pre-

pared it by the condensation of isobutaldehyde with ethylic malonate; Schryver's acid melted at 99—100°, Knoevenagel's at 96·5—97°. The authors find that by far the largest yield of this acid is obtained in the following way.

Ethylic β -isopropylacrylate. $\text{Pr}^\beta \cdot \text{CH} : \text{CH} \cdot \text{CO}_2\text{Et}$, prepared by eliminating hydrogen bromide from ethylic α -bromisobutylacetate by means of diethylaniline, is a mobile liquid, boiling at 174°, which, on condensation with ethylic sodiocyanacetate in alcoholic solution gives a mixture of a neutral and a hydrogen ethylic salt. Ethylic α -cyano- β -isopropylglutarate, $\text{EtO}_2\text{C} \cdot \text{C}(\text{CN})\text{H} \cdot \text{CH}(\text{Pr}^\beta) \cdot \text{CH}_2 \cdot \text{CO}_2\text{Et}$, is a colourless oil boiling at 195° (30 mm.), whilst the hydrogen ethylic salt, $\text{HO}_2\text{C} \cdot \text{C}(\text{CN})\text{H} \cdot \text{CH}(\text{Pr}^\beta) \cdot \text{CH}_2 \cdot \text{CO}_2\text{Et}$, is a dark coloured oil which splits off carbon dioxide on distillation and passes into ethylic γ -cyano- β -isopropylbutyrate, $\text{CN} \cdot \text{CH}_2 \cdot \text{CH}(\text{Pr}^\beta) \cdot \text{CH}_2 \cdot \text{CO}_2\text{Et}$, a mobile liquid boiling at 234°.

The neutral ethylic salt on hydrolysis with methyl alcoholic potash, yields a solid potassium salt, which, on boiling a short time with concentrated hydrochloric acid, becomes the imide, $(\text{Pr}^\beta)\text{CH} < \begin{smallmatrix} \text{CH}_2\text{CO} \\ \text{CH}_2\text{CO} \end{smallmatrix} \text{NH}$, a solid substance crystallising from water in lustrous plates melting at 120°, and which is quantitatively converted into β -isopropylglutaric acid on boiling for two hours with a 50 per cent. solution of sulphuric acid.

β -Isopropylglutaric acid, $\text{HO}_2\text{C} \cdot \text{CH}_2 \cdot \text{CH}(\text{Pr}^\beta) \cdot \text{CH}_2 \cdot \text{CO}_2\text{H}$, prepared either in this way or by the direct hydrolysis of the hydrogen ethylic salt with sulphuric acid, crystallises from water in needles melting at 100°, and on treatment with acetyl chloride yields a liquid anhydride boiling at 171° (30 mm.), and an anilic acid crystallising from dilute alcohol in plates melting at 121°.

This acid does not appear to be identical with that obtained by Angeli and Rimini (*Gazz. Chim.*, 26, 36) from isocamphor on oxidation with potassium permanganate, which melts at 96° and gives an anhydride melting at 60°, further the dissociation constant K 0·0646 of the authors' acid, as found by Mr. Lidbury, does not agree with K 0·0052 of Angeli and Rimini's acid.

56. "The synthesis and preparation of terebic and terpenylic acids." By W. Trevor Lawrence.

The tertiary hydrogen atom in monobasic aliphatic acids is readily oxidised by potassium permanganate (R. Meyer and Fittig).

The author has applied this method to the synthesis of terebic and terpenylic acids.

β -Isopropylglutaric acid is readily oxidised by chromic acid mixture,

The corresponding dibenzoylglycerates, previously prepared by P. Frankland and MacGregor (Trans., 1896, 69, 104) have the following rotations :—

Methylic dibenzoylglycerate	(m. p. 58·9°) ...	$[\alpha]_D^{20} = +26·67^\circ$
Ethylic	„ (m. p. 25°) ...	„ = +26·08

Thus in this series, again, the *p*-toluyl group has the greatest, and the *o*-toluyl group the least, rotatory effect. The rotatory effect of the benzoyl is almost identical with that of the *m*-toluyl group.

The dextrorotation of all these compounds diminishes with increase of temperature.

The rotatory effects of the isomeric toluyl groups is again found to follow in the same order as that of their molecular volumes, the *p*-toluyl having the largest, and the *o*-toluyl-compounds the smallest, molecular volumes. The molecular volumes of all these compounds are distinctly in excess of the values calculated by means of Traube's formula, and thus afford no evidence of association.

58. "Fencholenic acid." By G. B. Cockburn, B.A., B.Sc.

The author shows that fenchonoxime, by treatment with dilute sulphuric acid, gives, not one nitrile, as Wallach states (*Annalen*, 1891, 263, 136), but a mixture of two isomerides. Of these, one (β) passes easily on saponification to a solid unsaturated acid, $C_9H_{15}CO_2H$, m. p. 72—73°, b. p. 259—260°. The other (α) is very stable, and only gives an acid after long saponification. This acid is isomeric with the former, but is liquid, and boils at 254—256°. Wallach describes the acid he obtained as a liquid, but it is probably a mixture of the above α - and β -acids. The boiling point of the nitrile, as given by Wallach, is 217—218°, whilst that of the pure β -nitrile reformed from the pure acid is 211—212°, and of the α -, 217—219°. Owing to the difference in behaviour of these two nitriles towards alcoholic potash, the separation of the two acids is comparatively simple.

This behaviour of fenchonoxime bears out the analogy existing between camphor and fenchone. The oximes of both these bodies, by the action of dilute acid, lose a molecule of water in two different ways, and give two isomeric unsaturated nitriles in each case; and these in their turn yield two corresponding acids, one solid, the other liquid.

59. "The action of certain acidic oxides upon salts of hydroxy-acids. Part IV." By G. G. Henderson, D.Sc., M.A.; T. W. Orr, and R. J. G. Whitehead.

The paper contains the results of investigations carried on in continuation of those formerly communicated to the Society (*Trans.*, 1895, 67, 102 and 1030; 1896, 69, 1451), and a discussion of the constitution of the compounds of the tartar emetic type.

Sodium, potassium, and ammonium molybdicitrates were prepared by boiling molybdenum trioxide with aqueous solutions of the corresponding primary citrates. They have the formula $\text{MoO}_2(\text{C}_6\text{H}_6\text{O}_7\text{M}')_2, x\text{H}_2\text{O}$, crystallise in colourless prisms, are readily soluble in water, and are decomposed by heat or light. The barium salt, $\text{MoO}_2(\text{C}_6\text{H}_6\text{O}_7)_2\text{Ba}, 5\text{H}_2\text{O}$, obtained by precipitation, is a white, crystalline powder almost insoluble in water. Decomposed by dilute sulphuric acid, it yields a solution which appears to contain molybdicitric acid, $\text{MoO}_2(\text{C}_6\text{H}_7\text{O}_7)_2$.

Tungstic oxide, boiled with solutions of mono-alkali citrates, gave *double tungsticitrates* of the formula $\text{WO}_2(\text{C}_6\text{H}_6\text{O}_7\text{M}')_2, \text{C}_6\text{H}_7\text{O}_7\text{M}', x\text{H}_2\text{O}$; the simple salts are not obtained. These salts form small, colourless crystals very readily soluble in water, and are not decomposed when heated to 120° . The double barium salt, $2\text{WO}_2(\text{C}_6\text{H}_6\text{O}_7)_2\text{Ba}, (\text{C}_6\text{H}_7\text{O}_7)_2\text{Ba}, 10\text{H}_2\text{O}$, prepared by double decomposition, crystallises in minute needles, soluble in water.

Sodium, potassium, and ammonium molybdimalates, $\text{MoO}_2(\text{C}_4\text{H}_4\text{O}_5\text{M}')_2, x\text{H}_2\text{O}$, were prepared like the molybdicitrates. The potassium salt crystallises in large, the sodium salt in small, colourless prisms, and the ammonium salt is a white, crystalline powder. All are readily soluble in water, and easily decomposed by exposure to heat or light. Another molybdimalate of sodium, of the formula $\text{MoO}_2:\text{C}_4\text{H}_3\text{O}_5\text{Na}, 1\frac{1}{2}\text{H}_2\text{O}$, was prepared by heating a solution of monosodium malate with excess of molybdic oxide. It crystallises in long, colourless needles, which are soluble in water, is very sensitive to light, and is decomposed by heating to about 90° .

Tungstic oxide is only dissolved with difficulty by solutions of alkali malates, but some *tungstimalates*, $\text{WO}_2(\text{C}_4\text{H}_4\text{O}_5\text{M}')_2, x\text{H}_2\text{O}$, were prepared. The sodium salt crystallises in small, the potassium salt in long, needles, the ammonium salt in delicate leaflets. They are readily soluble in water, and can be heated to 105° without decomposition.

With solutions of mono-alkali mucates, molybdic oxide gives in the first instance unstable double salts, $2(\text{MoO}_2:\text{C}_6\text{H}_7\text{O}_8\text{M}'), \text{C}_6\text{H}_9\text{O}_8\text{M}', x\text{H}_2\text{O}$, which are easily soluble in water, and yield the simple *molybdimucates*, $\text{MoO}_2:\text{C}_6\text{H}_7\text{O}_8\text{M}', x\text{H}_2\text{O}$. The potassium and ammonium salts are white,

crystalline powders, fairly easily soluble in water, and decomposed by heating to about 90° . When dry they are fairly stable to light, but their solutions are quickly acted upon.

Potassium tungstimate, $\text{WO}_2 \cdot \text{C}_6\text{H}_7\text{O}_8\text{K} \cdot 3\text{H}_2\text{O}$, was prepared similarly, but with difficulty. It forms minute, lustrous crystals, and is extremely readily soluble in water, and more stable towards heat or light than the molybdimucate.

Potassium molybdilactate, $\text{MoO}_2(\text{C}_3\text{H}_4\text{O}_3\text{K})_2$, the only crystalline derivative of lactic acid we have succeeded in preparing, was obtained in the form of small, colourless crystals, very readily soluble both in water and in dilute alcohol. It is not very sensitive to light when dry.

Silica was found to be almost insoluble, even when used in the hydrated state, in solutions of all the salts examined.

Sodium, potassium, ammonium titanitartrates, $\text{TiO}(\text{C}_4\text{H}_4\text{O}_6\text{M}')_{2,x}\text{H}_2\text{O}$, were prepared in the usual way. Hydrated titanitic oxide was used, because the anhydrous oxide is practically insoluble in solutions of tartrates. The salts crystallise in small, colourless prisms readily soluble in water. Alcohol precipitates from a solution of the ammonium salt a crystalline solid whose composition approximates to the formula $\text{TiO} \cdot \text{C}_4\text{H}_3\text{O}_6\text{NH}_4$. A white barium salt, almost insoluble in water, is obtained by precipitation.

The corresponding *stannitartrates*, $\text{SnO}(\text{C}_4\text{H}_4\text{O}_6\text{M}')_{2,x}\text{H}_2\text{O}$, were prepared similarly. They form small, colourless crystals fairly easily soluble in water. Heating of their solutions in water for any length of time causes slow decomposition of the salts, but in the dry state they are quite stable. From solutions of the potassium and ammonium salts, alcohol precipitates crystalline solids, which appear to have the formula $\text{SnO} \cdot \text{C}_4\text{H}_3\text{O}_6\text{M}'$. A white barium salt, almost insoluble in water, was also prepared.

Potassium titanicitrate, $\text{TiO}(\text{C}_6\text{H}_6\text{O}_7\text{K}_2)_2 \cdot \text{H}_2\text{O}$, and *ammonium stannicitrate*, $\text{SnO}(\text{C}_6\text{H}_6\text{O}_7\text{NH}_4)_2 \cdot \frac{1}{2}\text{H}_2\text{O}$, were obtained by a similar process, though with some trouble. They form small, white crystals very readily soluble in water and soluble in dilute alcohol. They are stable when dry, but gradually decompose if their aqueous solutions are heated.

The hydrated dioxides of titanium and tin were found to dissolve in boiling aqueous solutions of mono-alkali malates, but no definite compounds were isolated.

With some difficulty, a *potassium titanimucate*, $\text{TiO} \cdot \text{C}_6\text{H}_7\text{O}_8\text{K} \cdot 3\text{H}_2\text{O}$, was prepared in the form of small, white crystals, easily soluble in water, not sensitive to light, and not decomposed at 100° . No corresponding compound of tin could be obtained.

ADDITIONS TO THE LIBRARY.

Donations.

Berthelot, M. *Chaleur Animale. Principes chimiques de la Production de la Chaleur chez les êtres vivants. I. Notions Générales.* Pp. xvi + 169. II. *Données Numériques.* Pp. 148. Paris, 1899.

From the Author.

Bolton, H. C. *A Select Bibliography of Chemistry, 1492—1897. First Supplement.* Pp. ix + 489. Washington, 1899. Smithsonian Miscellaneous Collections, 1170. From the Smithsonian Institution.

Mason, W. P. *Examination of Water (Chemical and Bacteriological).* Pp. 135. New York, 1899. From the Publishers.

Reychler, A. *Outlines of Physical Chemistry.* Translated by John McCrae. Pp. xvi + 276. London, 1899. From the Publishers.

II. *Purchase.*

Boltzmann, Ludwig. *Vorlesungen über Gastheorie. II. Theil. Theorie van der Waals'; Gase mit zusammengesetzten Molekülen; Gasdissociation; Schlussbemerkungen.* Pp. x + 265. 8vo. Leipzig 1898.

Van der Waals, J. D. *Die Continuität des gasförmigen und flüssigen Zustandes. Zweite, verbesserte Auflage. I. Theil.* Pp. vii + 182. 8vo. Leipzig 1899.

Pamphlets.

Australasian Association for the Advancement of Science. *Report on the Composition and Properties of the Mineral Waters of Australasia.* Sydney 1898.

Spring, W. *Sur l'origine de la couleur bleue du ciel.* Bruxelles 1898.

True, F. W. *An Account of the United States National Museum.* From the Report of the U.S. National Museum for 1896. Washington 1898.

COLLECTIVE INDEX.

Fellows can obtain the Collective Index 1873—1882 from the Assistant Secretary at the price of 10s., or 11s. including carriage. The price of the Collective Index 1883—1892 is 16s. including carriage.

RESEARCH FUND.

A meeting of the Research Fund Committee will be held in June. Forms of application for Grants can now be obtained from the Assistant Secretary.

At the next meeting, on May 4th, there will be a ballot for the election of Fellows, and the following papers will be communicated by the authors:—

“On the combustion of carbon disulphide.” By Harold B. Dixon and E. J. Russell.

“The action of nitric oxide on nitrogen peroxide.” By Harold B. Dixon and J. D. Peterkin.

“On the mode of burning of carbon.” By Harold B. Dixon.

“Crystalline glycollic aldehyde.” By H. J. H. Fenton and Henry Jackson.

“On the blue salt of Fehling’s solution and other cupro-tartrates.” By Orme Masson and B. D. Steele.

“The preparation of acid phenolic salts of dibasic acids.” By S. B. Schryver, D.Sc., Ph.D.

“The maximum pressure of naphthalene vapour.” By R. W. Allen, M.A.

PROCEEDINGS
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No. 209.

May 4th, 1899. Professor Thorpe, F.R.S., President, in the Chair.

Messrs. David Hooper and W. H. Mills were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. Henry Meldola Danziger, Clent House, Woodland Road, Northfield, Birmingham; William Gordon Fraser, Golspie, St. Albans; Henry Royal-Dawson, 3, Kenilworth Road, Ealing, London, W.; Samuel Stansfield, White Lee, Mytholmroyd, Manchester; Christopher Joseph Whittaker, Willow House, Blackburn Road, Accrington.

A ballot for the election of Fellows was held, and the following were subsequently declared duly elected:—

James Herbert Allworthy, Peter Auchinachie, Clement Harrison Baker, Frederick James Beale, Frank Belton, Benjamin Harvey Bennetts, Alfred Ernest Bond, George Smith Bratby, Kendall Colin Browning, B.A., William Collingridge, M.A., Robert D. Connell, Charles Robert Darling, Harold Francis Carl Goltz, Percy Haigh, John Elias Hughes, Archibald Glen Kidston Hunter, Lauder William Jones, B.A., Ph.D., Thomas Judge, B.A., Robert William Lindsey, James MacLeod, William McConnell, Wilfred Walter Morris, Laurence C. Panting, B.A., M.B., Frederick Williams Pittuck, Harold McLean Read, S. B. Schryver, D.Sc., Ph.D., Maurice Emile Schweich, Edward Thomas Shelbourn, Arthur John Shelton, Harry Alexander Thiersch, Robert Tatlock Thomson, Richard Threlfall, Ernest Albert Tyler, B.A., Arthur Luvian Wade, Allan Frederick Walden, M.A., Charles Walker, Fred Sheasby Watson, B.Sc.

Of the following papers, those marked * were read :—

***60. "On the combustion of carbon disulphide." By Harold B. Dixon and E. J. Russell.**

The authors have investigated the temperature of ignition of carbon disulphide in air, its stability on heating, its mode of burning in air in the divided flame, and its explosion with oxygen.

Experiments on the ignition point of carbon disulphide showed considerable variations. It was found that the vapour undergoes a phosphorescent combustion in air similar to that of phosphorus, sulphur, ether, &c. This phosphorescence is well seen in a dark room when the vapour impinges on a glass vessel at 230°. The lowest temperature at which actual ignition was observed was 232°. Carbon disulphide distilled in a current of nitrogen through a porcelain tube heated to 400° showed no visible decomposition. When carbon disulphide was sealed up in a glass tube and submitted to prolonged heating at 230°, a slight yellow film formed on the glass. A similar film was produced by the prolonged action of bright light.

Although carbon disulphide is decomposed by a violent shock (*e.g.*, an explosion of fulminate) into its elements, this decomposition is not propagated through its vapour as an explosion, but dies out. When carbon disulphide is exploded with defect of oxygen, it does not yield a deposit of carbon. When it is exploded in a long tube with an excess of oxygen, the products of the combustion are mainly those required by the equation $\text{CS}_2 + 3\text{O}_2 = \text{CO}_2 + 2\text{SO}_2$, but there are always present small quantities of carbon disulphide, oxysulphide, and monoxide with the excess of oxygen.

When carbon disulphide is exploded in a long tube with insufficient oxygen for complete combustion, the products are carbon dioxide and sulphur dioxide along with carbon oxysulphide and monoxide, sulphur, and unchanged carbon disulphide. As the oxygen is gradually diminished, the amount of sulphur dioxide falls off, whilst the carbon monoxide increases. The authors were unable to set up the explosion-wave in mixtures containing less than 40 per cent. of oxygen. So far as the experiments could be carried, there was always a division of the oxygen between the carbon and sulphur. No simple equation expresses the mode of burning. In the incomplete combustion of carbon disulphide, the sulphur was deposited partly in the 'liquid' condition.

The maximum velocity of the explosion-wave was found when the oxygen just sufficed for complete combustion.

When carbon disulphide vapour and air are burnt as the Smithells' divided flame, the products of the inner flame are sulphur dioxide and carbon monoxide in nearly equal volumes, some unchanged carbon

disulphide, and only small quantities of carbon dioxide and oxysulphide.

DISCUSSION.

Professor TILDEN said that it seemed to him impossible to determine or to state exactly the temperature of ignition of any combustible substance, inasmuch as this depends largely upon conditions such as the proportion of air present, and especially the extent of the heated surface by which the action is started. As an example, the very small, though very hot, sparks from a flint and steel are known to be incapable of inflaming a mixture of coal gas and air, while a red-hot iron bar, though at much lower temperature, does cause ignition by reason of its greater mass.

Dr. WYNNE said that in purifying carbon bisulphide for the purpose of determining its magnetic rotation, the late Mr. Rodger, by exposing the liquid to sunlight, had obtained some quantity of the brown substance with a view of determining its composition. The prevalent idea seemed to be that the brown substance was a subsulphide, possibly C_2S_3 , and it would be interesting to know whether Professor Dixon had any evidence bearing on the point.

Professor SMITHELLS said that he could confirm Professor Dixon's remark as to the phosphorescent combustion of carbon disulphide. This substance might be added to the long list of carbon compounds which were capable of phosphorescent combustion. The combustion of carbon disulphide was of special interest from the fact that the flame did not exhibit the so-called carbon or candle spectrum, but this he believed could be explained by the masking effect of the burning sulphur. He had found that a burning mixture of ethylene and hydrogen sulphide gave no carbon spectrum, although an ethylene air flame of itself would of course do so. He had made some examination of the partial products of combustion of carbon disulphide; they were difficult to deal with, and he was glad that Professor Dixon had brought the inquiry to a successful issue. It was interesting to remark that some years ago Julius, from an examination of the spectrum of burning carbon disulphide, had concluded that some third substance besides carbon dioxide and water was formed, and he had detected carbon oxysulphide. Professor Dixon, however, had gone much further in establishing this fact.

***61. "The action of nitric oxide on nitrogen peroxide." By Harold B. Dixon and J. D. Peterkin.**

Some few years ago, the question was keenly debated whether nitrogen trioxide existed in the gaseous state. On both sides, the final appeal was made to the behaviour of nitric oxide when mixed

with gaseous nitrogen peroxide. Ramsay and Cundall (*Trans.*, 1895, 67, 672) broke an inner tube, containing nitric oxide over mercury, by pressing it against an outer tube containing the peroxide over mercury. No contraction was observed. The experiment proved that no considerable quantity of trioxide could have been formed on mixing the gases. Lunge and Porschnew (*Zeit. anorg. Chem.*, 1894, 7, 209) broke a thin glass diaphragm between a vessel containing nitric oxide and a similar one containing the peroxide. The gases showed a very slight expansion on diffusing "instead of the large contraction expected." The natural conclusion of chemists has been that "gaseous N_2O_3 apparently does not exist."

But the dissociation which nitrogen peroxide undergoes on diminution of pressure would have caused an appreciable expansion in these experiments if the nitric oxide had merely played the part of an inert gas.

The authors confirm Lunge and Porschnew's conclusion that a very slight alteration of volume occurs on mixing nitric oxide with the peroxide at 27° , but they show that a considerable expansion occurs when the peroxide mixes with nitrogen and other inert gases, and that this observed expansion is in close agreement with that calculated from Willard Gibbs' formulæ for the dissociation of the peroxide. The authors infer from their experiments that at 27° nitric oxide and peroxide combine to a limited extent to form an unstable compound, which is largely dissociated at this temperature, and undergoes increasing dissociation as the temperature is raised. The reversibility of the equation $N_2O_3 = NO + NO_2$ affords an easy explanation of the behaviour of the mixed gases towards reagents.

DISCUSSION.

Professor RAMSAY congratulated Professor Dixon on having shown that in the gases evolved from nitrous anhydride, which consist chiefly of a mixture of nitric oxide and peroxide, a small amount of gaseous nitrous anhydride is to be detected. The power of this mixture of gases to react as N_2O_3 is thus explained. In 1885, he (Professor Ramsay) stated that, as the result of experiments showing that, in the main, the gases obtained from liquid anhydride consist of NO_2 , N_2O_4 , and NO , "it cannot be taken as conclusive that no nitrous anhydride is present in the gaseous state"; and Professor Dixon has found that a small proportion does so exist. The proof is valuable, inasmuch as it explains why the mixture of gases can act on sulphuric acid, be absorbed by soda, and act as a diazotising agent.

Professor DEWAR said that, in his paper, "Studies on the Electric Arc" (*Proc. Roy. Soc.*, 1880, 30, 85), experiments are described

showing the amount and character of the oxides of nitrogen produced when an arc is maintained in a cool dry moving atmosphere. The quantity of oxides formed did not exceed 1 gram per hour. As the solution of the oxides in concentrated sulphuric acid gave the same percentage of nitrogen whether treated directly with mercury or after careful dilution with water and subsequent titration of the solution with permanganate, it was inferred that the main product was gaseous nitrous anhydride.

Experiments are also described in an address on "Phosphorescence and Ozone" (*Proc. Roy. Inst.*, 1888, 12, 557), which have an important bearing on this question. A current of attenuated air was maintained in a small vacuum tube of the ordinary form, and after the passage of the electric discharge was allowed to expand into a glass cylinder 3 feet long and 6 inches in diameter, maintained at a pressure not exceeding 6 or 8 mm. by means of a large air pump. The result was the production of extraordinary phosphorescent effects in the stream of air. This phosphorescence is associated with the production of ozone and oxides of nitrogen, as it does not take place in the absence of oxygen. Recently, the phosphorescent glow was allowed to pass through some liquid air in order to condense and solidify the oxides of nitrogen and dissolve the ozone out of the moving, luminous gas stream. The result was that the clear liquid air soon became turbid from the formation of a precipitated greenish-blue solid. On filtering this off, it gave all the reactions of nitrous acid, and no ozone was found in solution. The colour of the body at the low temperature shows it was not N_2O_4 , which is colourless. It might be, however, a mixture of nitric oxide and nitrous anhydride. On the other hand, it is possible that NO_2 , the dissociated molecule of N_2O_4 , may exist in the solid state at the very low temperature and be coloured.

Mr. C. E. GROVES said that, many years ago, in the course of experiments on the preparation of nitrosyl sulphate, he had found that the brown vapours given off when arsenious anhydride was heated at 70° with nitric acid of sp. gr. = 1.3 were almost entirely absorbed by concentrated sulphuric acid. Crystalline nitrosyl sulphate was formed, and but little, if any, nitric acid, although the latter should have been produced if nitric peroxide had been present. More recently, he had observed that these same vapours, when passed into a mixture of crushed ice and water, were absorbed, forming a solution of nitrous acid.

Professor TILDEN said it was generally acknowledged that nitrogen trioxide existed only in the form of the blue liquid, which becomes almost completely dissociated by vaporisation. Professor Dixon seemed to have proved that in this case, as in so many others, a dis-

sociable compound is more stable in the presence of the products of its dissociation.

***62. "On the mode of burning of carbon." By Harold B. Dixon.**

In the combustion of carbon, the formation of carbon dioxide is usually described as being due to a single and direct action between carbon and oxygen; it is stated or implied that carbon monoxide is only formed by a secondary action between carbon dioxide and carbon. The only experiments which claim to prove this are the two series made by Julius Lang (*Zeit. phys. Chem.*, 1888, 2, 168).

The author repeated Lang's experiments, and found that when oxygen was passed over carbon heated to 500° (a temperature at which Lang showed carbon dioxide was not reduced by carbon), even in a very slow stream, some carbon monoxide was always formed.

Under conditions far less favourable for the reduction of carbon dioxide than in Lang's experiments, viz., by passing a mixture of carbon dioxide with 6—8 per cent. of oxygen over carbon heated to 500°, some carbon monoxide was always formed.

Lang's more important argument depends on his second series of experiments, which consisted in passing a mixture of oxygen, carbon monoxide, and nitrogen over carbon at 500°. He found that with a slow stream the carbon monoxide remained unchanged in amount, whilst all the oxygen was converted into carbon dioxide; with a quicker stream, the proportion of carbon monoxide increased considerably, but with a still quicker stream it was much reduced. The author has made many experiments to test these results. When a mixture containing about 80 per cent. of oxygen and 20 per cent. of carbon monoxide, was passed quickly over coke heated to 500°, the blue flame of burning carbon monoxide was observed, and the amount of that gas found in the products was small. On lowering the rate of the gas stream, the flame was not formed, but the carbon glowed and the amount of carbon monoxide in the products increased. This reached a maximum and then diminished as the rate of the stream was continually lowered. With a very slow stream, from 2—4 per cent. of carbon monoxide was found in the products. These results are quite opposed to the conclusions drawn by Lang, viz., that carbon monoxide is unaltered when, mixed with oxygen, it is passed very slowly over carbon at 500°. His argument that carbon dioxide must be first formed is therefore invalid.

The results of the new experiments might be explained on either hypothesis if it be assumed that the molecule of the monoxide, or of the dioxide, as the case may be, formed by the direct union of the

elements at 500° , retains sufficient heat (from its heat of formation) to react with oxygen or carbon respectively. The experiments of Baker (*Phil. Trans.*, 1888, 179 A, 571), make it very probable that the carbon burns first to carbon monoxide.

DISCUSSION.

Professor CLOWES said that Haldane (*Trans. Inst. Mining Engineers*, 16, 470), had shown that a small proportion of carbon monoxide accompanied carbon dioxide in the products of the spontaneous oxidation of coal at ordinary temperatures. The carbon monoxide was detected by the reaction with diluted blood, its proportion was estimated by this colorimetric method, and the result confirmed by the ordinary gasometric method.

***63. "Crystalline glycollic aldehyde." By Henry J. Horstman Fenton and Henry Jackson.**

It has previously been shown by one of the authors (*Trans.*, 1895, 67, 774) that dihydroxymaleic acid, when heated with water, breaks up almost quantitatively into glycollic aldehyde and carbon dioxide, $C_4H_4O_6 = C_2H_4O_2 + 2CO_2$.

The resulting solution, after purification by treatment with calcium carbonate and extraction with alcohol, yields, on evaporation in a vacuum, a colourless, sweet syrup, which was shown to be the aldehyde in nearly a pure state. Traces of the solvent used for purification, however, are obstinately retained, and various attempts have been made to obtain the substance absolutely pure.

It was further shown (*Trans.*, 1897, 71, 375) that this syrup, when heated to 100° in a vacuum, polymerises to a large extent, giving a hexose, $C_6H_{12}O_6$. During this operation, a small quantity of crystalline substance was often observed in the exit tube of the apparatus employed, but the quantity was too minute for thorough examination. By taking certain precautions, the authors now find that this crystalline substance can be obtained in fair quantity, that it is invariably produced in the process referred to, and on examination proves to be pure glycollic aldehyde.

Molecular weight determinations by the cryoscopic method indicate that, in the crystalline state, the substance is probably bimolecular, the numbers obtained when the solution is first made approximating to those required for the double formula $C_4H_8O_4$. But on allowing the solution to stand, this value diminishes, and, after about 24 hours, becomes constant, and agrees almost exactly with that required for

the single formula. This behaviour is quite analogous to that which Wöhl observed in the case of crystalline glyceraldehyde (*Ber.*, 1898, 31, 2394).

*64. "On the blue salt of Fehling's solution and other cuprotartrates." By Orme Masson and B. D. Steele.

In this paper, electrolytic and chemical experiments are described which prove (*a*), that the blue salt contains a complex negative radicle of which copper is a part; (*b*), that none of the copper plays an electro-positive part; (*c*), that when a current passes through the blue solution, copper is deposited on the cathode by secondary action of the *K* ions there; (*d*), that the blue solution may be prepared perfectly neutral to litmus by the interaction of cupric tartrate and alkali in the ratio of 5KOH to $4\text{CuC}_4\text{H}_4\text{O}_6$, and that this neutral solution contains $\text{K}_2\text{C}_4\text{H}_4\text{O}_6$ as well as the blue salt; (*e*), that the latter may be completely purified by precipitating it with alcohol; (*f*), that when dried in vacuo it has the composition $\text{K}_3\text{C}_{12}\text{H}_9\text{Cu}_4\text{O}_{19}\cdot 4\text{H}_2\text{O}$; (*g*), that it gives rise to the production, by double decomposition, of a series of salts of the heavy metals, obtained as more or less insoluble, blue, amorphous precipitates, of which the silver and lead salts have been analysed; (*h*), that the free acid corresponding to these cuprotartrates is unstable and, so far, unobtainable; (*i*), that excess of alkali converts the neutral blue cuprotartrate into a strongly alkaline salt, which is also capable of being separated by alcohol.

DISCUSSION.

Dr. THORNE said the blue salt has been recently examined in his laboratory by his assistant, Mr. E. H. Jeffers. It had been obtained by precipitation as a viscid liquid gradually depositing crystals, but it had not yet been isolated in a pure state. It was readily soluble in water, and the aqueous solution did not show any decomposition on boiling.

It is remarkable that the whole of the copper should be present in the negative condition. The complicated formula assigned to the salt seemed improbable, as Luff has recently (*Zeits. ges. Brauw.*, 1898, 21, 319) described a potassium cupric citrate, $\text{K}_2\text{Cu}(\text{C}_6\text{H}_4\text{O}_7)\cdot 6\text{H}_2\text{O}$, obtained in an analogous way. This latter salt appears to be an ordinary double salt with the copper in the positive condition, but its behaviour with reducing sugars is similar to that of the tartrate described.

*65. "The preparation of acid phenolic salts of dibasic acids." By
S. B. Schryver, D.Sc., Ph.D.

When the sodium salt of a phenol is treated with the anhydride of an organic dibasic acid in the presence of a liquid, such as a hydrocarbon, which exerts no chemical action on either the phenol sodium salt or the anhydride, a reaction takes place, which may be represented by the following general equation:— $R \begin{smallmatrix} \diagup \text{CO} \\ \diagdown \text{CO} \end{smallmatrix} \text{O} + \text{XONa} = R \begin{smallmatrix} \diagup \text{COOX} \\ \diagdown \text{COONa} \end{smallmatrix}$, where R = residue of an organic dibasic acid, X = a phenylic group.

The hydrocarbon most generally employed was xylene. The phenol was dissolved in about ten times its weight of the hydrocarbon, and the sodium salt prepared by the direct action of metallic sodium on this solution. On adding the anhydride, an immediate action takes place in most cases, and the sodium phenolic salt separates out on standing in the form of a gelatinous mass. This can be dissolved up in water and thus separated from the hydrocarbon, and the acid phenolic salt can be precipitated from the aqueous solution of the sodium salt thus obtained by the addition of dilute mineral acids. By means of the reaction, the following substances were prepared:—

Phenol hydrogen camphorate, $\text{CO}_2\text{H} \cdot \text{C}_8\text{H}_{14} \cdot \text{CO}_2(\text{C}_6\text{H}_5)$, m. p. 100° .
Thymol hydrogen succinate, $\text{CO}_2\text{H} \cdot \text{C}_2\text{H}_4 \cdot \text{CO}_2(\text{C}_{10}\text{H}_{14})$, m. p. $121-122^\circ$.
Thymol hydrogen phthalate, $\text{CO}_2\text{H} \cdot \text{C}_6\text{H}_4 \cdot \text{CO}_2(\text{C}_{10}\text{H}_{14})$, m. p. 132.5° .
Thymol hydrogen camphorate, $\text{CO}_2\text{H} \cdot \text{C}_8\text{H}_{14} \cdot \text{CO}_2(\text{C}_{10}\text{H}_{14})$, m. p. 89° .
Guaiacol hydrogen succinate, $\text{CO}_2\text{H} \cdot \text{C}_2\text{H}_4 \cdot \text{CO}_2(\text{C}_6\text{H}_4 \cdot \text{OCH}_3)$, m. p. 75° .
Guaiacol hydrogen camphorate, $\text{CO}_2\text{H} \cdot \text{C}_8\text{H}_{14} \cdot \text{CO}_2(\text{C}_6\text{H}_4 \cdot \text{OCH}_3)$, m. p. 112° , from which the neutral salt, $\text{C}_8\text{H}_{14}(\text{CO}_2\text{C}_6\text{H}_4 \cdot \text{OCH}_3)_2$, m. p. 124° , was prepared.
 β -Naphthol hydrogen camphorate, $\text{CO}_2\text{H} \cdot \text{C}_8\text{H}_{14} \cdot \text{CO}_2\text{C}_{10}\text{H}_7$, m. p. $120-121^\circ$. Eugenol hydrogen camphorate, m. p. 115.5° . Carvacrol hydrogen camphorate, a syrup.

As will be seen from the above examples, the reaction is applicable to a large number of phenols and acid anhydrides, but it does not apply, however, universally. So far, two classes of exceptions have been discovered amongst substituted phenols.

(1). The ortho- and para-nitrophenols.—Whereas the sodium salt of metanitrophenol dissolves readily in a 10 per cent. solution of camphoric anhydride in xylene, neither the corresponding ortho- nor para-compounds react, even when heated to 180° in a sealed tube. Reference is made to the differences in the reactions of meta-compounds, as opposed to the corresponding ortho- and para-compounds, in the publications of Menschutkin (*Ber.*, 1897, 30, 2968) and Lobry de Bruyn (*Rec. Trav. Chem.*, 1894, 13, 101—147). The metanitrophenol camphorate, $\text{CO}_2\text{H} \cdot \text{C}_8\text{H}_{14} \cdot \text{CO}_2\text{C}_6\text{H}_4(\text{NO}_2)$, prepared by the reaction,

commences to melt at 115° , but is not completely molten till some degrees higher.

(2). Diortho-substituted phenols.—A series of bromo-compounds was prepared, viz., *p*-bromophenol, 2:4-dibromophenol, 2:6-dibromophenol, 2:4:6-tribromophenol. 2:6-Dibromophenol was obtained by the reduction of 2:6-dibromoparanitrosophenol ($\text{OH} = 1$) and subsequent replacement by hydrogen of the amino-group in the product thus obtained by means of ethyl nitrite. The other bromophenols were obtained by direct bromination.

It was found that, whereas *p*-bromophenol and 2:4-dibromophenol readily reacted with camphoric anhydride yielding camphorates, $\text{CO}_2\text{H} \cdot \text{C}_8\text{H}_{14} \cdot \text{CO}_2\text{C}_6\text{H}_4\text{Br}$ and $\text{CO}_2\text{H} \cdot \text{C}_8\text{H}_{14} \cdot \text{CO}_2\text{C}_6\text{H}_3\text{Br}_2$, melting respectively at 111° and 173° , neither the 2:6-dibromophenol nor the 2:4:6-tribromophenol reacted, even when heated to 180° in a sealed tube. This non-reactivity is analogous to the non-formation of alkyl salts of diortho-substituted benzoic acids (compare V. Meyer and Sudborough, *Ber.*, 1894, 27, 510, 512, 1580, 3146). V. Meyer ascribes the non-reactivity to stereochemical causes. In this case, as well as in the reactions described above, it seems doubtful whether the non-reactivity is to be ascribed to the presence merely of two substituted groups in the ortho-position (stereochemical causes), or to the close proximity of two strongly negative groups—in other words, to statical or dynamical causes—especially when the fact is taken into account that even certain mono-substituted products are incapable of reacting.

DISCUSSION.

Dr. LAPWORTH thought that Dr. Schryver's observations afforded further evidence in favour of the view that in the salts of ortho- and para-nitrophenols the constitution of the nucleus is no longer benzenoid, but quinonoid; that is to say, that the salts are derivatives of iso-nitro-compounds analogous to quinoneoximes, and not to true phenols. In the case of metanitrophenol, as the migration of the phenolic hydrogen into the nitro-group is not possible, and as nitrobenzenes do not form salts, it is probable that the salts of metanitrophenol are true phenolates.

66. "The maximum pressure of naphthalene vapour." By R. W. Allen, M.A.

An accurate knowledge of the amount of naphthalene required to saturate a given volume of gas at various temperatures is of great importance to gas engineers. The author has therefore determined

the vapour pressure of naphthalene both by the "evaporation" and the "barometric" methods, and obtained results which are in entire accord, but which differ notably, especially at the lower temperatures, from the few measurements given by Naumann. The paper contains tables giving the pressures obtained by both methods as well as one giving the weight of naphthalene required to saturate a cubic metre of gas at temperatures varying from 0° to 130°.

67. "Scoparin." By Arthur George Perkin.

Scoparin, the colouring matter of broom (*Spartium Scoparium* L.) was discovered by Stenhouse (*Annalen*, 1851, **78**, 17), who assigned to it the provisional formula $C_{21}H_{22}O_{10}$ (mean of analyses, C=57.67; H=5.34). Hlasiwetz (*Annalen*, 1866, **138**, 190) included scoparin in the quercetin group, for, on fusion with alkali, it gave phloroglucinol and protocatechuic acid.

The similarity of the dyeing properties of scoparin and vitexin pointed to their close relationship (*Trans.*, 1893, **73**, 1019). The results of Stenhouse and Hlasiwetz (*loc. cit.*) have been confirmed as analysis gave C=57.60, H=5.09, and fusion with alkali at 220°, phloroglucinol and protocatechuic acid. Digested with hydriodic acid, one molecule of methylic iodide is evolved (found, $CH_3=3.88$), and a new colouring matter, *scoparein*, results, distinguished from scoparin by its strong tinctorial properties. With boiling potassium hydrate solution, scoparin gives phloroglucinol, vanillic acid, and a third substance, $C_9H_{10}O_3$ (found, C=64.82; H=6.17), colourless needles m. p. 114°. As this latter contains one methoxy-group (found, $CH_3=9.65$), reacts with semicarbazide, and on fusion with alkali gives protocatechuic acid, it is a *dihydroxyacetophenonemonomethyl ether* (probably $OH : OCH_3 : COCH_3 = 1 : 2 : 4$).

Solutions of vitexin and scoparin in sulphuric acid, when heated, both develop a dull green coloration. The former, by decomposition with alkali, gives *p*-hydroxyacetophenone and phloroglucinol, and it is thus very probable that scoparin is a *methoxy-vitexin*. The author intends to investigate this colouring matter further.

68. "On a new compound of arsenic and tellurium." By E. C. Szarvasy, Ph.D., and C. Messinger, Ph.D.

Whilst investigating the compounds which arsenic forms with the elements of the oxygen group, a regularity in their properties was observed, which led to the discovery of a new telluride. The investigation aimed chiefly at a study of the behaviour of these compounds

at high temperatures, and the determination of their molecular weights by means of their vapour densities.

Selecting from each group of the compounds examined those most stable at high temperatures, a certain numerical regularity was observed between their molecular weights. In the series of compounds having the formulæ As_2O_3 , As_2S_2 , As_2Se , the differences between the molecular weights of such a series are 16 and 15 units respectively. Similarly, we may determine the formula of the next probable tellurium compound higher in the series, having the same difference between it and the preceding member. Calculation indicated the formula of this compound to be As_8Te_3 . It was subsequently prepared by melting its components together in the ratio $8\text{As} : 3\text{Te}$ in a sealed tube under pressure. The vapour density of this compound was also determined. The paper concludes with a comparison of the properties of the compounds which arsenic forms with the various elements of the oxygen group.

69. "The action of hydrogen peroxide on secondary and tertiary aliphatic amines. Formation of alkylated hydroxylamines and oxamines." By Wyndham R. Dunstan and Ernest Goulding.

In a previous communication (*Proc.*, 1899, 15, 58), the authors have shown that methyl iodide reacts with hydroxylamine, forming *trimethylamine oxide* or *trimethyloxamine*, $(\text{CH}_3)_3\text{N}:\text{O}$, whilst ethyl iodide forms first β -*diethylhydroxylamine*, $(\text{C}_2\text{H}_5)_2\text{NOH}$, and by further action *triethyloxamine*, $(\text{C}_2\text{H}_5)_3\text{N}:\text{O}$.

The constitution of these oxamines suggested the possibility of their formation from the corresponding amines by the action of weak oxidising agents. The authors find that trimethylamine is readily oxidised in aqueous solution by standing in the cold with a dilute solution of hydrogen peroxide, forming *trimethyloxamine* identical in properties with the compound already described. Similarly, triethylamine is readily oxidised to *triethyloxamine*. In both cases, the yield is nearly quantitative. Diethylamine, under the same conditions, is converted into β -*diethylhydroxylamine* identical with the compound prepared by the authors by the reaction of ethyl iodide with hydroxylamine. Experiments are now being made with other amines and with ammonia.

70. "The enantiomorphously related tetrahydroquinaldines." By William Jackson Pope and Stanley John Peachey.

Dextrotetrahydroquinaldine was obtained by Ladenburg (*Ber.*, 1894, 27, 77) by crystallising the externally compensated base with

tartaric acid, when dextrotetrahydroquinaldine bitartrate is eventually obtained in a state of purity. Lævotetrahydroquinaldine has not previously been prepared.

On dissolving externally compensated tetrahydroquinaldine in hot water by addition of a half-molecular proportion each of hydrochloric and dextro- α -bromocamphorsulphonic acids and allowing to cool, *lævotetrahydroquinaldine dextro- α -bromocamphorsulphonate*, $C_{10}H_{13}N, C_{10}H_{14}BrO \cdot SO_3H$, separates in almost quantitative yield. The salt is sparingly soluble in water, and is purified by two or three recrystallisations from alcohol; it crystallises in colourless needles melting at $218-220^\circ$, and on treatment with soda the base separates as an oil, which is extracted with ether and purified by distillation under reduced pressure.

Lævotetrahydroquinaldine, $\begin{array}{c} CH:CH \cdot C \cdot CH_2 \cdot CH_2 \\ CH:CH \cdot C \cdot NH \cdot CHMe \end{array}$, is a colourless, highly refractive oil of faint basic odour, and boils at 158° under 59 mm. pressure. It has a specific gravity of 1.0236 at $14.5/4^\circ$, and gives the rotation $\alpha_D = -58.60^\circ$ in a 100 mm. tube at 16° ; the specific rotation is therefore $[\alpha]_D = -57.25^\circ$. For the rotations of the dextro-isomeride, Ladenburg gives $\alpha_D = +58.35^\circ$ and $[\alpha]_D = +55.99^\circ$, having apparently used the density of the externally compensated base in calculating the specific rotation.

Benzoyl-lævotetrahydroquinaldine, $C_{10}H_{12}N \cdot CPh$, is readily obtained, by shaking the base with dilute soda and benzoyl chloride, as a granular crystalline mass, which is purified by crystallisation from ethyl acetate. It separates from cold acetone in lustrous colourless monosymmetric prisms melting at $117-118^\circ$, and has the specific rotation $[\alpha]_D = +247.3^\circ$ in a 3.5 per cent. benzene solution. A comparison of its properties with those of Walter's optically inactive benzoyltetrahydroquinaldine (*Ber.*, 1892, 25, 1261) shows that the latter is a true racemic compound.

After filtering off the *lævotetrahydroquinaldine dextro- α -bromocamphorsulphonate*, the mother liquor is made alkaline, and the crude dextrotetrahydroquinaldine extracted with ether, and converted into dextrocamphorsulphonate by addition of the requisite quantity of Reychler's camphorsulphonic acid (*Bull. Soc. Chim.*, 1898, [iii], 19, 120); a crystalline substance separates which, after repeated recrystallisation from acetone, yields *dextrotetrahydroquinaldine dextrocamphorsulphonate*, $C_{10}H_{13}N, C_{10}H_{15}O \cdot SO_3H$. This salt crystallises in colourless needles melting at $127-128^\circ$, and has the specific rotation $[\alpha]_D = +45^\circ$ in a 4 per cent. aqueous solution; it yields Ladenburg's dextrotetrahydroquinaldine when treated with soda. *Lævotetrahydroquinaldine dextrocamphorsulphonate*, $C_{10}H_{13}N, C_{10}H_{15}O \cdot SO_3H$, also crystallises well,

separating from acetone solution in long, colourless needles melting at 137—138°; it has the specific rotation of $[\alpha]_D = -16^\circ$.

Benzoyldextrotetrahydroquinaldine, $C_{10}H_{12}N \cdot CPh$, is completely analogous to its enantiomorphously related isomeride; it melts at 117—118° and has the specific rotation of $[\alpha]_D = -247.4^\circ$ in a 4 per cent. benzene solution. The benzoyl derivatives now described are hydrolysed by prolonged boiling with hydrochloric acid, yielding benzoic acid and the original base.

RESEARCH FUND.

A meeting of the Research Fund Committee will be held in June. Application for Grants, to be made on forms which can be obtained on application to the Assistant Secretary, must be received on or before May 31st.

COLLECTIVE INDEX.

Fellows can obtain the Collective Index 1873—1882 from the Assistant Secretary at the price of 10s., or 11s. including carriage. The price of the Collective Index 1883—1892 to Fellows is 16s. including carriage.

At the next meeting, on May 18th, the following papers will be communicated by the authors:—

- “Corydaline. Part VI.” By J. J. Dobbie, Ph.D., and A. Lauder.
 “Oxidation of furfural by hydrogen peroxide.” By C. F. Cross, E. J. Bevan, and T. Freiberg.

PROCEEDINGS
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Vol. 15.

No. 210.

May 18th, 1899. Professor Thorpe, F.R.S., President, in the chair.

Messrs. H. H. Bowles, F. S. Young, and R. Haliburton Adie were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. George Dekeyne Atkinson, c/o Crowley and Co., The Brewery, Alton, Hants; James Connah, GERALTON, Carlton Road, Sidcup; Robert McClumpha, 372 Westgate Road, Newcastle-on-Tyne; Eskricke Sidney Phillips, Christ's College, Cambridge; John William Shepherd, 48 Ovington Street, S.W.; Charles Simmonds, 17 Ruvigny Gardens, Putney, S.W.

Of the following papers, those marked * were read.

*71. "Corydaline. Part VI." By James J. Dobbie and Alexander
Lauder.

In this paper, the authors give the results of the investigation of *corydaldine*, $C_9H_7NO(OCH_3)_2$, one of the substances obtained by the oxidation of corydaline by means of potassium permanganate (*Trans.*, 1894, 65, 57). By employing a smaller proportion of permanganate and using it at the ordinary temperature, a larger yield was obtained than by the method previously described.

Corydaldine readily dissolves in water, melts at 175° , and contains two methoxyl groups. Dissolved in hydrochloric acid and treated with sodium nitrite at 0° , a yellow nitroso-derivative is obtained (m. p. 185°), which is very insoluble in hot and cold water. When this nitroso-derivative is gently warmed with a solution of sodium

hydrate, nitrogen is evolved, and on addition of hydrochloric acid to the solution a new substance, melting at 138—139°, is obtained, which is the anhydride of a monobasic acid. Its formula is $C_{11}H_{12}O_4$; it is difficultly soluble in cold but readily in boiling water, from which it crystallises well on cooling. Treatment with hydrogen iodide proves that it contains two methoxyl groups, and oxidation with permanganate at 100° converts it into metahemipinic acid. Heated with hydrochloric acid at 150°, a phenolic derivative (m. p. 232°) is obtained, which shows all the reactions of ω -hydroxyethylcatechol-carboxylic anhydride obtained by Perkin from berberine (*Trans.*, 1890, 57, 1028). The authors therefore conclude that *corydaldine* only differs from ω -amidoethylpiperonylcarboxylic anhydride in having two methoxyl groups instead of the piperonyl group, and that it is closely related to oxy-hydrastinine.

Corydaline is thus proved to be closely related to berberine, hydrastine, narcotine, and papaverine, in common with which it contains an isoquinoline nucleus. When the alkaloid is oxidised at 100° by means of potassium permanganate, the chief product is a mixture of hemipinic and metahemipinic acids.

The substance previously described under the name of corydalinic acid (*Trans.*, 1894, 65, 57) is found to be an acid ammonium salt of metahemipinic acid, having the formula $C_{10}H_{10}O_6 \cdot C_{10}H_9O_6(NH_4) \cdot 3H_2O$.

***72. "Oxidation of furfural by hydrogen peroxide." By C. F. Cross, E. J. Bevan, and T. Heiberg.**

The results described in this paper are obtained by interaction of the aldehyde and peroxide in dilute aqueous solution (2—4 per cent. furfural) at 40° in presence of iron salts in small quantity. The peroxide is added until the characteristic reaction of the aldehyde with aniline acetate is no longer obtainable, the quantity of peroxide required being two to three molecules per molecule of furfural.

The main product of oxidation is recognised by its reactions with phenylhydrazine (formation of hydrazone), and with phloroglucinol and hydrochloric acid (deep red-violet coloration followed by precipitation of the colouring matter) to be a furfural derivative. Analysis of the hydrazone shows it to be the hydrazone derivative of a *hydroxy-furfural*. Along with this main product is an acid, which is easily separated as a barium salt insoluble in acetic acid. Analyses of the barium and lead salts show the acid to be the corresponding *hydroxy-pyromucic* acid.

The substitution of hydroxyl for hydrogen in the furfurane nucleus agrees with the results of previous investigations as to the mode of action of the peroxide; but, as a further confirmation, its action

on benzene under conditions similar to those in the above described experiments has been so far studied as to prove the formation of a considerable quantity of phenol. The furfural-phenol corresponds to an oxybenzaldehyde; reasons are given for regarding the OH and CHO-groups as occupying the 1:2-positions. It is noteworthy that, as in the case of the normal saturated "carbohydrates," the CHO-group is but slowly attacked by the peroxide relatively to a CH-group.

The further action of the peroxide is destructive in character, the furfurane ring being broken down, the chief product being formic acid, along with some acetic and oxalic acids. The intermediate products appear from their reactions to be hydroxyketonic acids. The formation of methylated compounds is probably a secondary result of the decomposition; from the products of the original reaction, iodoform is obtainable in some quantity, and the amounts have been estimated.

Special interest attaches to the hydroxyfurfural which has been thus obtained. Its reactions with phloroglucinol and with resorcinol in presence of HCl are similar to those of the lignocelluloses. These colours may be developed on a pure cellulose cloth or paper for comparative study. It is then seen that the brilliant colours of the original products—blue with resorcinol, violet with phloroglucinol, give place to "flattened" shades, grey and brown respectively, on washing with ordinary water.

By means of these reactions, it is now shown (1) that a furfural-phenol is a constituent of the lignocelluloses; (2) that the colour reactions of these 'natural' products with the hydroxybenzenes are due to the presence of such compounds; (3) that the equally characteristic reactions of the lignocelluloses with aniline salts are reactions with a second constituent group, *e.g.*, the keto-R-hexene complex.

A furfural-phenol being a normal product of the condensation processes accompanying lignification, it is probably also a product of the action of the condensing acids used in estimations of furfural. It appears, therefore, that the furfural actually isolated does not necessarily represent the entire production of furfurane derivatives; and these observations supply the basis for a further differentiation of the complex group of furfural-yielding plant constituents or furfuroids.

DISCUSSION.

Mr. F. S. Young said that, as the result of some preliminary experiments, he had found that, although hydrogen peroxide by itself attacks benzene only very slowly, an extremely energetic reaction takes place in the presence of ferrous salts. A complete examination of the products of the reaction has still to be made; but he had proved that a considerable quantity of phenol is formed.

In two preliminary experiments, in which one molecule and two molecules of hydrogen peroxide were used for one molecule of benzene, the yield of phenol was 10 per cent. and 20 per cent. respectively; and it is possible that this yield may be increased when the most favourable conditions for its formation have been determined. Pyrocatechol was also obtained as a product of the reaction.

Mr. FENTON said that the results obtained by Messrs. Cross and Young with furfural and benzene, together with those which had been observed by himself and others in the case of phenol, appeared to establish a third typical reaction of hydrogen peroxide in presence of iron—namely, the replacement of hydrogen by hydroxyl.

With reference to Mr. Cross's suggested explanation of the mechanism of the reaction, he did not think that it was applicable to the cases which he (Mr. Fenton) had studied, since other oxidising agents might be substituted for the hydrogen peroxide.

Mr. Cross, in reply, said, with regard to the mechanism of the action of hydrogen peroxide, that although the tendency of the peroxide to split into hydrogen and oxygen might not be suggested by its interactions with inorganic compounds, yet its behaviour with carbon compounds, especially those which are unsaturated, might furnish evidence of such intermediate phases as would disappear in the final stages of the reaction.

***73. "Note on the reactions between sulphuric acid and the elements."**

By R. H. Adie.

The publication of a paper by M. Berthelot on the action of sulphuric acid on metals (*Ann. Chim. Phys.*, 1898, [vii], 14, 176—204), leads the author to publish the results of some experiments which he performed some years ago. The results obtained by Berthelot in the case of zinc confirm those of Muir and the author (*Trans.*, 1888, 53, 47), and in the case of copper, those of Pickering (*Trans.*, 1878, 33, 112). In the following table, the temperatures of decomposition of sulphuric acid by the easily obtainable elements are given, these being grouped according to the periodic system.

It appears possible, even at this stage, to draw a few conclusions.

(i) Sulphuric acid is decomposed by most elements, with the formation of sulphur dioxide and hydrogen. Sulphuretted hydrogen only appears as a special impurity in a few cases.

(ii) In any group of elements, the decomposition temperature becomes lower as the atomic weight of the element increases.

(iii) Copper, nickel, and palladium all form black sulphides, and also all give compounds with ammonia.

(iv) In the case of zinc, a pure specimen (kindly given by Professor Ramsay) caused the temperature of decomposition to rise to 250°. With this specimen, no hydrogen sulphide was evolved up to the boiling point of the acid. This suggests the unsuitability of ordinary zinc for further work.

Element.	SO ₂ appears.	H ₂ S appears.	Notes.
Hydrogen ...	170°	None.	(Gas prepared from Zn and HCl washed and dried with H ₂ SO ₄ .
Copper	{ Begins 110—115° Continuous 120°	None.	Cu ₂ S formed.
Silver	175°	None.	Gas evolved at 150°.
Magnesium...	215°	Trace.	
Zinc.....	250°	None.	SO ₂ evolved as soon as reaction starts.
Cadmium	205°	Trace?	
Mercury	120°	None.	Gas given off at 110°.
Aluminium...	235°	None.	No bubbles of SO ₂ .
Carbon.....	188°	None.	
Tin	145°	None.	S formed.
Lead	140°	None.	
Thallium.....	Below 20°	Below 20°.	{ Formed at once at ordinary temperature. Brown solid formed. No AsH ₃ .
Arsenic	110°	None.	
Antimony ...	90—95°	None.	
Bismuth	90°	None.	Gas evolved at once.
Sulphur	200°	None.	Melts at 220° No bubbles till 230°.
Selenium.....	170°	None.	
Molybdenum.	135°	None.	{ Gas begins at 115°. Green solid formed.
Tungsten ...	175°	None.	
Manganese ...	155°	None.	Gas evolved at 120°.
Iodine	—	—	Passes over at 92°. No action before.
Iron.....	220°	None.	Gas evolved at 170°.
Nickel	145°	None.	Black solid formed.
Cobalt	240°	None.	
Palladium ...	200°	None.	{ Reaction not vigorous. Blackens from formation of sulphide.
Platinum	None.	None.	

The author intends to make a fuller investigation of some of the more definite reactions.

74. "On the action of ethylene dibromide and of trimethylene dibromide on the sodium derivative of ethylic cyanacetate." By H. C. Harold Carpenter and William H. Perkin, jun.

One of the great difficulties in investigating the derivatives of trimethylene is the fact that the condensation of ethylene bromide with the sodium compounds of ethyl malonate and ethyl acetoacetate gives only a very small yield of trimethylene compounds (*Trans.*, 1885, 47, 808); and again, in investigating the formation of tetramethylene compounds by the action of trimethylene bromide on the

sodium derivative of ethyl malonate, the best yield of ethyl tetramethylenedicarboxylate (1,1) obtained was only 33 per cent. (*Trans.*, 1887, 51, 3).

It appeared to us possible that the yield of these closed-chain compounds might be considerably increased if ethyl cyanacetate was substituted for ethyl malonate and acetoacetate, and this has been found to be the case.

Ethyl trimethylenecyancarboxylate (1,1), $\begin{array}{c} \text{CH}_2 \\ | \\ \text{CH}_2 \end{array} > \text{C} < \begin{array}{l} \text{CN} \\ \text{CO}_2\text{Et} \end{array}$, of which 50—60 per cent. is obtained by the action of ethylene bromide on the sodium derivative of ethyl cyanacetate, is a colourless, mobile liquid, boiling at 210—211° under 766 mm. pressure, $\Delta_{\text{D}}^{20} = 1.0783$. It dissolves gradually in aqueous ammonia (sp. gr. = 0.88) forming the amide, which crystallises in lustrous needles (m. p. 160°). Cold methyl alcoholic potash saponifies it instantly, with the production of the potassium salt of *trimethylenecyancarboxylic acid* (1,1). The acid is obtained in the form of long, colourless prisms by the evaporation of its ethereal solution in a stream of dry air. It melts undecomposed at 148°. It is remarkable that all attempts to split off the carboxyl group and prepare cyantrimethylene, (i) by distilling the acid, (ii) by heating it in sealed tubes with a small quantity of water, (iii) by heating the silver salt, have failed. Recently, however, this substance has been prepared by L. Henry, who distilled γ -chlorbutyronitrile repeatedly over solid potash and obtained it in the form of a colourless liquid of pleasant odour. B. p. = 135°, $\Delta^{160} = 0.911$ (*Bull. Acad. roy. Belgique*, 1898, [iii], 36, 34; 1899, [iii], 37, 17—22).

The silver salt is a very characteristic substance. It is soluble in water, and crystallises from its aqueous solution in lustrous prisms. The conversion of the trimethylenecyancarboxylic acid into trimethylenedicarboxylic acid is best effected by boiling with aqueous potash. From the latter acid, its characteristic derivative, bromethylmalonic acid (m. p. 116°) was prepared by the action of aqueous hydrobromic acid (sp. gr. = 1.83).

The condensation of ethylene bromide with the sodium derivative of ethyl cyanacetate yields, besides the trimethylene derivative, two crystalline substances, the one melting at 119°, the other at 95—96°, according as the reaction is made to take place under pressure in soda-water bottles or at ordinary pressures. These substances have been analysed, but their constitutions have not yet been discovered.

Ethyl tetramethylenecyancarboxylate (1,1), $\begin{array}{c} \text{CH}_2 - \text{CH}_2 \\ | \quad \quad | \\ \text{CH}_2 - \text{C}(\text{CN}) \cdot \text{CO}_2\text{Et} \end{array}$, is obtained to the extent of 60—70 per cent. by the action of trimethylene bromide on the sodium derivative of ethylcyanacetate. It is a colourless liquid boiling at 213—214° under 766 mm. pressure, $\Delta_{\text{D}}^{20} = 1.0633$.

It dissolves in aqueous ammonia (sp. gr. = 0.88), but the resulting amide is easily soluble and does not crystallise out. Cold methyl alcoholic potash saponifies it at once, forming the potassium salt of *tetramethylenecyancarboxylic acid* (1,1). The free acid is purified by crystallisation from carbon disulphide containing a small quantity of ether, and is thus obtained in long, silky needles, which have the remarkably low melting point 69—70°. By careful heating, they may be sublimed unchanged. The silver salt is completely analogous to that of the corresponding trimethylene acid. Boiling aqueous potash hydrolyses the cyanogen group, and the product is tetramethylenedicarboxylic acid (1,1), which melts at 157°. The characteristic lead salt was prepared and analysed. The by-product in the preparation of the ethyl tetramethylenecyancarboxylate is an oil. The investigation of this substance is in progress.

75. "The maximum vapour pressure of camphor." By R. W. Allen, M.A.

By the two methods which he employed in determining the vapour pressures of naphthalene (*Proc.*, 1899, 15, 122), the author has determined the maximum pressures of camphor vapour from 0—80°. The results obtained by these methods agree throughout, but differ very notably from those obtained by Ramsay and Young (*Phil. Trans.*, 1884, 175, 45).

CERTIFICATES OF CANDIDATES FOR ELECTION
AT THE NEXT BALLOT.

N.B.—The names of those who sign from “General Knowledge” are printed in *italics*.

The following Candidates have been proposed for election. A ballot will be held on Thursday, June 15th, 1899.

Aders, Robert Henry,

28, St. John's Wood Road, N.W.

Student, University College, London. Student for B.Sc. Lond. Exam., and have worked since October, 1897, in Chemical Laboratory, University College, London.

William Ramsay.

A. M. Kellas.

Morris W. Travers.

G. Nevill Huntly.

S. Smiles.

Atkinson, George Dekeyne,

c/o Crowley and Co., The Brewery, Alton, Hants.

Brewer. Medical, passed in Chemistry in 1882, London; Member of the Institute of Brewing since foundation; Member of the Belgian Association of Chemists; studied Chemistry of Brewing in Technical Laboratory. Fifteen years' Brewing experience, and interested in the Biological and Chemical Research work connected therewith.

Chas. Geo. Matthews.

Horace T. Brown.

George Harrow.

G. Harris Morris.

Jas. O'Sullivan.

John Heron.

Adrian J. Brown.

Bean, Percy,

42, Granville Road, Blackburn.

Analytical Chemist. Lecturer on “Textile Chemistry” at the Harris Institute, Preston, and the Darwen Technical School, and late Lecturer on Inorganic and Textile Chemistry at Blackburn ditto. Author of “The Origin, Development, and Classification of Iron Stains in Cotton Cloth.” First Classes at South Kensington Examinations in

both Advanced Inorganic Theory and Advanced Practical Inorganic Chemistry.

Edward Davies.

E. Haworth.

C. Gerland.

Wm. Hall Jowett.

J. W. Clayton.

Blackman, Walter Lionel,

Mostyn, Mount Nod Road, Streatham, S.W.

One year General Science at St. Bartholomew's Hospital; $2\frac{1}{2}$ years Chemistry, Organic and Inorganic, at the Royal College of Science, London. Since then research work at St. Bartholomew's Hospital.

W. J. Russell.

W. Palmer Wynne.

William A. Tilden.

F. D. Chattaway.

K. J. P. Orton.

Carpmael, Wilfred,

24, Southampton Buildings, Chancery Lane.

Chartered Patent Agent. I was from October, 1885, to August, 1887, a Student of Chemistry at the University of Berlin under Prof. A. W. von Hofmann, and have for the past 12 years had great experience in drawing chemical specifications and discussing chemical inventions with inventors, having during the first part of that time been in the employment of, and recently a member of, the firm of Carpmael and Co.

James Dewar.

R. Meldola.

Alfred Gordon Salamon.

Walter F. Reid.

F. E. Allhusen.

Connah, James,

Geralton, Carlton Road, Sidcup.

Analyst in the Government Laboratory. B.Sc. (Lond.) (Honours, Chemistry); F.I.C.; Student in Chemistry, Royal College of Science, 1884—1885; Lecturer in Agricultural Chemistry at City of London College and Birkbeck Institution, 1890—1893.

T. E. Thorpe.

C. Proctor.

H. J. Helm.

J. Woodward.

E. Grant Hooper.

J. H. Robbins.

Danziger, Henry Meldola,

Cleut House, Woodland Road, Northfield, Birmingham.

Chemist. Student in the Owens College Laboratories for four years. Chemist to the King's Norton District Council.

J. Carter Bell.

H. B. Dixon.

William A. Bone.

W. H. Perkin, jun.

G. H. Bailey.

Doyle, Frederick,

8, Woodlands Terrace, Middlesbrough.

Science Teacher. Lecturer on Chemistry for the last four years at Middlesbrough High School.

J. G. Taylor.

J. Archyll Jones.

Wm. Goddard.

Duncan T. Richards.

William Lewins.

Dunscombe, Frederick Charles,

54, Woodstock Road, Bristol.

Analytical Chemist. Three years' course Merchant Venturers' School, Applied Science Department; Second Class Honours Practical Inorganic Chemistry, Intermediate Honours Practical Metallurgy, Advanced Stage Theoretical Inorganic Chemistry and Metallurgy (all at South Kensington Examinations); three years Assisant at the Clifton Laboratory, Bristol.

Ernest H. Cook.

George George.

Henry J. Palmer.

Arnold Philip.

James Leicester.

Sydney Young.

G. P. Darnell-Smith.

Eichenauer, William Frederick,

58A, Maryon Road, Old Charlton, Kent.

Analytical Chemist and Electrician. Chief Assistant in the Laboratory of Messrs. Siemens Brothers and Co. for 18 years. Have had considerable experience in Analytical and Electrochemical work. Assisted the late Dr. Obach in carrying out his well-known researches on gutta percha and indiarubber.

Henry Durham.

Thomas Bolas.

Isaac S. Scarf.

W. Kellner.

Herbert Jackson.

Fleischmann, Friedrich Noel Ashcroft,

6, Collingham Gardens, South Kensington, London; Magdalen College, Oxford.

Undergraduate of Magdalen College, Oxford. Student in Honour School of Natural Science (Chemistry).

Henry A. Miers.

J. E. Marsh.

John Watts.

G. Stallard.

H. L. Bowman.

W. W. Fisher.

E. G. J. Hartley.

Fraser, William Gordon,

Golspie, St. Albans.

Chemical Student. Have studied Chemistry at the City and Guilds

Technical College (under Professor Meldola) and obtained the College Certificate in Organic Chemistry (Evening Classes). Have devoted some considerable time to the investigation and analysis of fats and oils.

R. Meldola.

A. Hall.

Arthur J. Chapman.

Arthur Ross.

R. L. Jenks.

Getman, Frederick Hutton,

196, Atlantic Street, Stamford, Conn., U.S.A.

Analytical Chemist. Assistant in Physics at Rensselaer Polytechnic Institute in 1895. Graduate of School of Analytical and Industrial Chemistry, University of Virginia; Assistant Editor of *Popular Science News*, New York (Department Physics and Chemistry); member American Chemical Society, Society Chemical Industry, American Association Advanced Science; Chemist to Berkshire Portland Cement Company.

Chas. Baskerville.

F. P. Dunnington.

J. W. Mallet.

F. P. Venable.

W. H. Chandler.

Hübner, Julius,

24, DeLanney's Road, Crumpsall, Manchester.

Chemist and Colourist. Teacher of Bleaching, Dyeing, and Printing and Paper Manufacture. Taught the above subjects for seven years at the Municipal Technical School, Manchester. Thirteen years' experience in Aniline Colour Works, Dye Works (Cotton, Wool, and Silk) and Paper Mill.

John Allan.

Alex. K. Miller.

James Grant.

William Thomson.

George H. Hurst.

Frank Scudder.

Johnson, Edward Charles,

Lithgow, N.S. Wales, Australia.

Assayer, Great Cobar Copper Mining Company. Over nine years Laboratory Assistant Government Analyst, Tasmania. Assayer, Silver King Mine, Zeehan, Tas. Assayer, Grubb's Silver Mg. Co., Zeehan, Tas. Assayer, Mt. Drysdale Gold Mg. Co., N.S.W. Assayer, The New Eldorado Gold Mg. Co., N.S.W. Investigations made by me re loss of silver by concentration of silver lead ore, Tasmanian Secretary of Mines Report, 1894—1895.

William M. Hamlet.

James Taylor.

Alexander Orr.

John C. H. Mingaye.

F. B. Guthrie.

Leon, Arthur Alexander,

13, Cleveland Square, Hyde Park, W.

Brewer. One year Chemistry with the Rev. A. Wentworth Jones, M.A. Two years in a brewery. Six months with Dr. Moritz and Dr. Morris studying special brewing chemistry, and am at present taking a course of Bacteriology at the "Hansen Laboratory" of the "Jenner Institute."

Horace T. Brown.

A. Wentworth Jones.

James H. Millar.

M. O. Forster.

G. Harris Morris.

McAlley, James,

Bankside, Falkirk.

Analytical Chemist. Studied Chemistry for 3 years with R. R. Tatlock, Readman, and Thomson, City Analysts, Glasgow, and obtained various prizes of value. Subsequently occupied the position of Assistant for about 1 year. At present Head Chemist to the Scottish Cyanide Co., Ltd., Leven, N.B., and have been engaged for the past $4\frac{1}{2}$ years in carrying out Experimental and Research Work in connection with the manufacture of cyanides.

R. R. Tatlock.

John Shields.

G. H. Gemmell.

William Ramsay.

Geo. W. MacDonald.

McClumpha, Robert,

372, Westgate Road, Newcastle-on-Tyne.

Analytical and Pharmaceutical Chemist. A member of the Pharmaceutical Society of Great Britain. Principal of the West End School of Chemistry, Newcastle, and was for some time Analytical Chemist in charge of the Laboratory of Mawson, Levan, and Weddell, Newcastle. I have had several years' experience as a Teacher and Demonstrator, and at present conduct classes at the above-named West End School of Chemistry.

Edward Davies.

Frederick Gilderdale.

C. Ranken.

T. H. Walker.

Prósper H. Marsden.

P. Phillips Bedson.

Parkes, George Alfred,

Muckamore Bleach Works, co. Antrim, Ireland.

Chemist (Works). Full Honours Technological Certificates in Bleaching, Dyeing, Printing, and Coal-tar Colours, City and Guilds of London Institute. Practical Honours Chemistry, South Kensington. Until recently Assistant to Dr. E. Knecht in the Dyeing Department of the Manchester Technical School. Lecturer in Calico and Linen Bleaching and Printing at the above schools. Also

Lecturer in Bleaching, Dyeing, and Printing in the Accrington and Middleton Technical Schools. Now appointed Chief Chemist to the York Street Flax Spinning Co., Ltd., Belfast.

Jas. Grant.

R. L. Taylor.

John Allan.

C. Rawson.

Thorp Whitaker.

Peachey, Stanley John,

48, Grange Road, S.E.

Senior Assistant Goldsmiths' Institute, New Cross, S.E. Joint author of following two papers: (1) "The Resolution of Racemic Tetrahydropapaverine" (*Trans. Chem. Soc.*, 1898); (2) "The Non-resolution of Tetrahydropapaverine by Tartaric Acid."

William J. Pope.

Sidney Williamson.

Gerald T. Moody.

Edwin C. Jee.

T. M. Lowry.

Phillips, Eskricke Sidney,

Christ's College, Cambridge.

School Master. B.A. Cambridge. Natural Science Tripos.

Charles T. Heycock.

W. T. N. Spivey.

W. J. Sell.

T. B. Wood.

H. J. H. Fenton.

Rossiter, Sidney,

19, Ranelagh Road, West Green, N.

Schoolmaster. Undergraduate of London University. Student at Bath, 1886—1887, under Mr. Gatehouse, F.I.C., public analyst, and for four years at East London Technical College, under Dr. Macnair and Dr. Hewitt. Teacher of Chemistry and Physics at Portman Place Higher Grade School, Mile End, since 1894. Taught Inorganic Chemistry (Science and Art Dept.), and had charge of Laboratory since 1897. Inorganic Chemistry (1st Advanced), Theoretical, 1897; Practical, 1894. Organic Chemistry (1st Ely.), Theoretical, 1898.

W. B. Hards.

D. S. Macnair.

Chas. T. F. Watts.

W. Mayhowe Heller.

Hugh Gordon.

Royal-Dawson, Henry,

3, Kenilworth Road, Ealing, London, W.

Analytical Chemist. Have received my general experience in Practical and Theoretical Chemistry at University College, Gower Street, W.C., during Sessions 1889—1890, 1890—1891, 1891—1892, after which period have devoted myself to Analytical Chemistry, gaining

experience in the analyses of minerals, food, and water, and am at present engaged on special work under Dr. Clowes.

William Ramsay.

J. H. Coste.

Frank Clowes.

Watson Smith.

R. Grimwood.

E. Brooke Pike.

Charles J. S. Makin.

Shepherd, William Frederick John,

12, Bridge Street Row, Chester.

Pharmaceutical and Manufacturing Chemist. Student in the School of the Pharmaceutical Society. Has passed Major Examination of the Society. Subsequently worked in the Research Laboratory of the Pharmaceutical Society. Joint author with Professor Dunstan of paper on "Identity of Caffeine and Theine" (*Journ. Chem. Soc.*, 1893, 63, 195).

Wyndham R. Dunstan.

Chas. T. F. Watts.

Chas. Umney.

W. F. Lowe.

G. Watmough Webster.

John C. Umney.

Shepherd, John William,

48, Ovington Street, S.W.

Lecturer on Chemistry. Student Glasgow Technical College. Atkinson Scholar, 1889—1892. Student Royal College of Science four years. Associate in Chemistry and in Geology. Bachelor of Science, London University. Various appointments as Science Teacher. Assistant Lecturer Salford Technical Institute.

T. E. Thorpe.

Gilbert T. Morgan.

W. Palmer Wynne.

Chapman Jones.

A. E. Tutton.

Simmonds, Charles,

17, Ruvigny Gardens, Putney, S.W.

Analyst. B.Sc., London. Student at Royal College of Science, 1887—1888. Analyst in Government Laboratory, London, 1888 to present time.

T. E. Thorpe.

J. H. Robbins.

H. J. Helm.

C. Proctor.

E. Grant Hooper.

J. Woodward.

Stainer, John Ward,

103, Cheriton Road, Folkestone.

Pharmaceutical Chemist. Pathological Chemist and Bacteriologist. Student of Yorkshire College, Leeds, 1886—1887. Pupil of Mr. Sidney

Harvey, F.I.C., Canterbury. Revision of Dr. Campbell Black's "Chemistry of Urine" (for publisher).

Arthur Smithells.

W. Lloyd Williams.

Sidney Harvey.

Francis H. Carr.

Herbert Ingle.

Peter MacEwan.

Stansfield, Samuel,

White Lee, Mytholmroyd, Manchester.

Senior Assistant and Science Instructor in the Pupil Teachers' Centre at the Hebden Bridge Central Schools. Bachelor of Science (Vict.). Associate of the Owens College. Four years student at the Owens College. Lecturer in Chemistry at the Hebden Bridge Science and Technical School.

H. B. Dixon.

G. H. Bailey.

W. H. Perkin, jun.

W. T. Lawrence.

D. S. Jerdan.

West, George Hardstaff,

Frankwell, Llanidloes.

Science Master in the County School, Llanidloes. B.Sc. (Lond.). Honours in Chemistry. Three years student at Mason College, Birmingham. One year student at Royal College of Science, London. Two years Science Master in the County School, Llanidloes.

William A. Tilden.

Charles A. West.

W. Palmer Wynne.

A. E. Tutton.

Chapman Jones.

Edward Russell.

Whittaker, Christopher Joseph,

Willow House, Blackburn Road, Accrington.

Chemical Manufacturer, Globe Chemical Works, Church. Councillor (Accrington Borough). Whitworth Scholar, 1880. Royal Exhibitioner, 1882. Honours, Chemistry, Agriculture, practical plane and solid Geometry, Machine Construction and Drawing, Steam, Applied Mechanics, &c. Teacher of Chemistry, Mathematics, Mechanics, &c., at the Accrington Mechanics' Institution for several years.

Thomas Whittaker, jun.

C. Gerland.

Joshua Bardsley.

Wm. Naylor.

J. H. Calvert.

RESEARCH FUND.

A meeting of the Research Fund Committee will be held in June. Application for Grants, to be made on forms which can be obtained on application to the Assistant Secretary, must be received on or before May 31st.

At the next meeting, on Thursday, June 1st, the following papers will be communicated by the authors:—

“The hydrosulphides, sulphides, and polysulphides of potassium and sodium.” By W. Popplewell Bloxam.

“On the relative efficiency of various forms of still-head for fractional distillation.” By Sydney Young, D.Sc., F.R.S.

“The salts of dimethylpyrone, and the tetravalence of oxygen.” By J. N. Collie, Ph.D., F.R.S., and T. Tickle.

PROCEEDINGS
OF THE
CHEMICAL SOCIETY.

EDITED BY THE SECRETARIES.

Vol. 15.

No. 211.

June 1st, 1899. Dr. W. H. Perkin, F.R.S., Vice-President, in the Chair.

Messrs. S. Wellington, P. J. D. Fielding, C. R. Darling, and H. M. Read were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. James Dick Dougall, Millom, Cumberland; Ernest Frederick Stephen Lange, Sunny Nook, Victoria Road, Withington, Manchester.

In response to an invitation from the University of Cambridge, the President was delegated by the Council to represent the Society at the Jubilee of Professor Sir G. G. Stokes, and in its name to present the following Address:—

To Sir GEORGE GABRIEL STOKES, Bart., M.A., D.C.L., LL.D.,
D.Sc., F.R.S.

WE, the undersigned, President and Officers of the Chemical Society, beg, on behalf of the Council and Fellows, to offer you our sincere and hearty felicitations on the occasion of your Jubilee as Lucasian Professor of Mathematics in the University of Cambridge.

The fifty years during which you have held a position so honourable in the ancient University which claims you as among the most distinguished of her sons have witnessed an extraordinary and unprecedented development in those branches of natural knowledge which are immediately connected with the work of your professorship. To this development your own labours as a teacher and an investigator have

contributed in no small degree. You have profoundly influenced the teaching of physics wherever this subject is taught, and this influence has of necessity extended into those departments of Chemical Science which are directly dependent upon, or are associated with, physics. We gratefully acknowledge the services you have rendered to chemical physics by your researches on hydrodynamics, by your contributions to the theory and practice of spectrum analysis, and by your optical investigations. Your memorable contribution to our own Journal, "On the Application of the Optical Properties of Bodies to the Detection and Discrimination of Organic Substances," made more than a third of a century ago, has borne fruit an hundredfold, and to-day the refractometer and the spectroscope are as indispensable to the chemist as is his balance. We are glad to recognise that your interest in our special field of inquiry, springing from that catholicity which is your characteristic, has in no wise abated, for there is hardly a chemical subject bordering upon those branches of physical research which you have made more especially your own that has not been elucidated and benefited by your kindly criticism and advice. There are many workers in our Society who thankfully acknowledge the ready help which you have rendered to them by your counsel and suggestions.

That you may long continue to enjoy, in health and prosperity, the esteem and respect with which you are universally held by those who labour for the advancement of knowledge and the spread of learning, is the heartfelt wish of every member of that body on whose behalf we now address you.

T. E. THORPE, *President.*

WILLIAM A. TILDEN, *Treasurer.*

WYNDHAM R. DUNSTAN, } *Secretaries.*

ALEXANDER SCOTT, }

RAPHAEL MELDOLA, *Foreign Secretary.*

Of the following papers, those marked * were read :—

***76. "The hydrosulphides, sulphides, and polysulphides of potassium and sodium." By W. Popplewell Bloxam.**

In this paper, the author shows that there is a very important difference between treating the aqueous solution of a sulphide and one of a hydrosulphide with sulphur. When sulphur is added to aqueous solutions of potassium and sodium sulphides, some thiosulphate is always formed along with the polysulphide, whilst hydrogen sulphide is evolved. This points to the sulphide having become, in part at least, hydrolysed into hydroxide and hydrosulphide. The action of sulphur on aqueous solutions of the pure hydrosulphides gives pure polysulphides with evolution of hydrogen sulphide.

The various wet and dry methods of preparing the sulphides and polysulphides of potassium and sodium described by the many authors who have worked at this subject have been repeated by the author, who concludes that (1) none of these authors could have obtained any polysulphide pure, but only a mixture of polysulphide and thiosulphate; (2) no method exists for separating the polysulphide from the thiosulphate.

The author has succeeded in obtaining the following hydrates of potassium sulphide: $K_2S, 2H_2O$; $K_2S, 5H_2O$; $K_2S, 12H_2O$. These salts can be dehydrated in a current of dry hydrogen, and the potassium sulphide remains stable at 560° . As $K_2S, 5H_2O$ loses $5H_2O$, it is evidently not $KHS, KHO, 4H_2O$. Sodium sulphide was obtained as $Na_2S, 9H_2O$.

By saturation of a solution of potassium hydroxide with hydrogen sulphide, crystals of the composition $2KHS, H_2O$ were obtained, which, like the hydrates of the normal sulphide, could be dehydrated without loss of sulphur. The hydrosulphide was quite stable at 560° .

According to Sabatier, the hydrated crystals of sodium sulphide are easily converted into sodium hydrosulphide by the action of hydrogen sulphide, but the author shows that solutions of sodium sulphide will only take up sufficient hydrogen sulphide to form the hydrosulphide under certain rather restricted conditions as to concentration and temperature. Under favourable conditions, two hydrates were obtained, $NaHS, 2H_2O$, $NaHS, 3H_2O$, the latter being the stable form.

To prepare the polysulphides, sulphur was dissolved in gently heated solutions of the hydrosulphides, when the following potassium compounds were obtained: $K_4S_5, 10H_2O$, $K_4S_8, 6H_2O$, $K_4S_8, 19H_2O$, K_4S_9, xH_2O , K_4S_{10}, xH_2O , as well as substances approximating in composition to K_4S_6 and K_4S_7 .

The only sodium compound obtained in this way was $Na_4S_9, 14H_2O$.

***77. "On the relative efficiency of various forms of still-head for fractional distillation." By Sydney Young, D.Sc., F.R.S.**

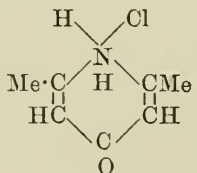
Experiments have been made to test the efficiency of the following forms of still-head, most of which are in general use: (1) plain vertical tubes of different lengths and widths; (2) sloping and spiral tubes; (3) vertical tube with bulbs (Wurtz); (4) the Hempel still-head; (5) the Glinsky dephlegmator; (6) the Le Bel-Henninger dephlegmator. In addition to these, a modified Young and Thomas dephlegmator and three new forms of still-head, descriptions of which are given in the paper, have been tested and compared with the others.

As the amount of liquid available for fractionation is often very limited, special attention has been paid to the suitability of the various forms of still-head for the distillation of small as well as of large quantities of liquid. Taking both efficiency and usefulness into account, it is shown that the new forms of still-head are superior to those in general use.

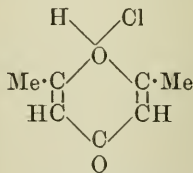
***78. "The salts of dimethylpyrone and the quadrivalence of oxygen."**
By J. N. Collie, Ph.D., F.R.S., and Thomas Tickle.

The authors have investigated the series of salts formed by dimethylpyrone with acids. Dimethylpyrone forms, in aqueous solutions with various acids, crystallisable salts. The hydrochloride, hydrobromide, hydriodide, nitrate, oxalate, tartrate, chloracetate, salicylate, picrate, and platinochloride were prepared; these compounds are produced by direct addition of the acid to the dimethylpyrone without the elimination of water, as in the equation $C_7H_8O_2 + HCl = C_7H_8O_2HCl$. On solution in much water, they again break up into dimethylpyrone and the free acid.

Taking into account the molecular structure of dimethylpyrone, the method of preparation, and the properties of these compounds, the authors are inclined to believe that their constitution is similar to that of the salts of nitrogenous and other bases.



Dimethylpyridone
chloride.



Dimethylpyrone
chloride.

This, however, assumes that oxygen may behave as a quadrivalent element. In favour of this hypothesis, the authors instance such compounds as dimethyl ether hydrochloride, diethyl ether hydriodide, ether peroxide, &c., and they suggest that should compounds similar to the salts they have examined contain nitrogen, phosphorus, sulphur, or iodine, they could be regarded as derived from the hypothetical bases NH_4OH , PH_4OH , SH_3OH , IH_2OH respectively; hence dimethylpyrone may be looked upon as a derivative of OH_3OH or *oxonium hydrate*.

79. "The symmetrical di-isopropylsuccinic acids." By William A. Bone and C. H. G. Sprankling.

The authors have succeeded in preparing two isomeric symmetrical di-isopropylsuccinic acids, by the action of isopropyl bromide on the sodium derivative of ethyl isopropyleyansuccinate, and subsequent hydrolysis of the ethereal salt so obtained.

The *trans*-acid, which is quite insoluble in benzene, melts at 226° and has a dissociation constant $k=0.0108$. The *cis*-acid, which dissolves in warm benzene, melts at $171-172^{\circ}$, and has a dissociation constant $k=0.2255$. Both acids, on treatment with acetyl chloride, give their anhydrides, which are liquid. The anhydrides dissolve in sodium hydrate, forming the sodium salts of the original acids. The anhydride of the *trans*-acid, on being boiled with acetic anhydride for several hours, is converted into the *cis*-anhydride, so that, in this way, the *cis*-acid can be obtained from the *trans*-modification. The behaviour of the new acids with acetyl chloride and acetic anhydride is thus in all respects similar to that of the symmetrical dimethylsuccinic acids. The calcium salts of both acids are sparingly soluble.

Previous workers (Hell and Mayer, *Ber.*, 1889, 22, 48; Auwers, *Ann.*, 1896, 292, 162) have been able to obtain only the *cis*-acid. Auwers (*loc. cit.*) states that symmetrical di-isopropylsuccinic acid, unlike other symmetrical di-alkylsuccinic acids, exists only in one modification. The authors are also completing an investigation on the symmetrical dipropylsuccinic acids.

80. "Active and inactive phenylalkyloxyacetic acids." By Alex. McKenzie, M.A., D.Sc.

The replacement of the alcoholic hydrogen in active malic, lactic, and tartaric acids by alkyl groups causes a striking increase of optical activity. The primary object of the investigation was to ascertain the effect of a similar replacement in the much more highly active mandelic acid.

For the preparation of the active alkylated mandelic acids, the method of alkylation recently applied by Purdie and Pitkeathly (*Trans.*, 1899, 75, 157) was adopted. Preliminary experiments with inactive mandelic esters showed that phenylalkyloxyacetic esters were produced. It was found convenient to start with free mandelic acid instead of its esters; thus, by the action of silver oxide and alkyl iodide on *i*-mandelic acid, phenylalkyloxyacetic acids were obtained.

By the interaction of silver oxide, ethyl iodide, and *l*-mandelic acid, a mixture of ethyl *l*-mandelate and *l*-phenylethoxyacetate results. After hydrolysis, *l*-phenylethoxyacetic acid was completely separated from mandelic acid as an oil. Polarimetric observations were made on the acid and on its sodium and barium salts.

l-Phenylmethoxyacetic acid is crystalline, m. p. 63—64°. The sparing solubility of its sodium salt in water afforded a ready method of separating it from mandelic acid. Rotations of the acid in various solvents and of several of its salts in water were made.

From *l*-mandelic acid, phenylpropyloxyacetic acid was obtained as an inactive oil; phenylisopropyloxyacetic acid was crystalline and active.

The molecular rotations of *l*-phenylmethoxyacetic acid and its salts are slightly higher than those of *l*-mandelic acid for equivalent concentrations. The rotations fall on dilution, a minimum being reached with the easily-dissociated salts, but with the acid, which in about 1/50 normal solution is 18 per cent. dissociated, the minimum had not been reached. Rimbach's results with *d*-mandelic acid (*Zeit. physikal. Chem.*, 1899, 28, 251) show similar relationships. The rotations for the ethoxy- and isopropyloxy-acids are considerably lower than those of *l*-mandelic acid.

Silver oxide has been used as an alkylating agent with tartrates and lactates without any observations of racemisation in the active products. Although every precaution was taken to avoid racemisation, so far, at least, as this is caused by violent action and rise of temperature, the propyloxy-acid was obtained inactive. Partial racemisation had also taken place in the preparation of ethyl *l*-phenylethoxyacetate by the silver salt method.

81. "The chemical composition of the oleo-resin of *Dacryodes Hexandra*." By A. More.

The oleo-resin consists of essential oil, a resin, and a white crystalline substance, $C_{25}H_{44}O$, melting at 166—167°.

The essential oil contains *levorotatory pinene* and *levorotatory sylvestrene*, which is the optical isomer of the sylvestrene described by Atterberg.

The crystalline substance is insoluble in water, and only sparingly soluble in strong alcohol. By the action of acetic anhydride, it yields a crystalline mono-acetate, m. p. 200°, and it therefore appears to be an alcohol. It is unaffected by potash and by all ordinary reagents. A tetranitro-derivative is produced by the action of fuming nitric acid. Chromic acid in acetic acid solution, while oxidising it, appears to cause two molecules to combine; the product is a feeble acid, the

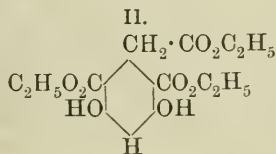
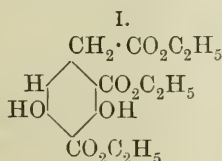
molecular weight of which was determined by the cryoscopic method. The substance is probably identical with Personne's ilicic alcohol, m. p. 175° , with which it agrees in composition, and which gives an acetyl derivative melting at $204-206^{\circ}$.

82. "The condensation of ethyl acetonedicarboxylate: the constitution of triethyl orcintricarboxylate." By David Smiles Jerdan.

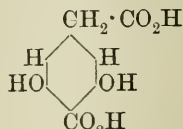
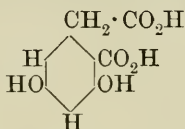
In the first part of this paper, the author discusses the action of condensing agents on ethyl acetonedicarboxylate. Two condensation agents have already been described, namely, a triethyl orcintricarboxylate, $C_{16}H_{20}O_8$ (Cornelius and von Pechmann, *Ber.*, 1886, 19, 1446; von Pechmann and Wolman, *Ber.*, 1898, 31, 2014), and a lactone, $C_{12}H_{10}O_7$, which was discovered by the author (*Trans.*, 1887, 71, 1106), and shown to be a derivative of phloroglucinol. Triethyl orcintricarboxylate was originally obtained by the action of sodium on ethyl acetonedicarboxylate, and afterwards by dissolving the ester in alcohol, saturating the solution with hydrogen chloride, and allowing the mixture to stand some weeks. The lactone, $C_{12}H_{10}O_7$, was first prepared by the action of sodium on ethyl acetonedicarboxylate dissolved in benzene. The author has recently found that both substances are formed by the action of sodium ethylate on an alcoholic solution of ethyl acetonedicarboxylate, and further, that small quantities of a number of metals and of their oxides are capable of bringing about the condensation of relatively large quantities of ethyl acetonedicarboxylate. Thus the ester, when heated with one-eight-hundredth part of its weight of sodium, gives a 30 per cent. yield of triethyl orcintricarboxylate. The probable course of this reaction is discussed.

A new condensation product, $C_{14}H_{16}O_8$, which melts at 141° , has been obtained by the action of magnesium on ethyl acetonedicarboxylate in presence of ethyl chloracetate, and has been shown to be a *diethyl orcintricarboxylate*. It is derived from the same orcintricarboxylic acid as the triethyl ester already mentioned, as is proved by its conversion into the triethyl ester by esterification.

The second part of the paper contains the results of an investigation into the constitution of triethyl orcintricarboxylate. Cornelius and von Pechmann (*loc. cit.*) pointed out that this substance may have one or other of the two formulæ :



The author has obtained from triethyl orcintricarboxylate, and from the diethyl orcintricarboxylate (m. p. 141°) already mentioned, derivatives of two orcinodicarboxylic acids, both of which have been shown to contain the group $-\text{CH}_2-\text{COOH}$. Only formula I, the asymmetric formula for triethyl orcintricarboxylate, admits of the formation of two such acids, namely:—



and accordingly this formula alone can correctly represent the constitution of triethyl orcintricarboxylate.

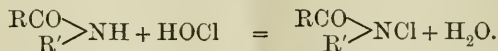
83. "A series of substituted nitrogen chlorides." By F. D. Chattaway and K. J. P. Orton.

Compounds in which halogen is attached to nitrogen have been little studied, although a number of isolated examples are known. In continuation of our work on nitrogen iodide, we have studied this nitrogen halogen linkage, and have obtained a very large number of compounds in which it occurs.

In this paper, the disubstitution products of nitrogen chloride are considered, containing formyl, acetyl, and benzoyl, together with a phenyl or a substituted phenyl residue.

These form a well-defined group of compounds, phenyl acetyl nitrogen chloride discovered by Bender being one of the simplest members.

They are readily obtained from the corresponding formanilide, acetanilide, or benzanilide by the action of hypochlorous acid under regulated conditions.



The method generally employed is to add gradually the calculated quantity of calcium hypochlorite to the anilide suspended in a saturated solution of potassium bicarbonate.

The substituted nitrogen chlorides are all stable solids of low melting point, crystallising well in large, colourless, transparent plates or prisms. They dissolve readily in chloroform, carbon bisulphide, and benzene, but only sparingly in ligroin.

They react very readily with hydrochloric acid, hydriodic acid, and alkaline hydrogen peroxide, liberating chlorine, iodine, and oxygen respectively, and reforming the anilide. They act with great energy upon aniline, giving chloranilines. The most remarkable change,

however, which these compounds undergo takes place when they are heated. When an unsubstituted phenyl group is attached to the nitrogen, the chlorine and the para-hydrogen atom of the nucleus change places, and a para-chloranilide is formed. With a para-chlorophenyl group attached to the nitrogen, a similar change takes place on heating, the chlorine, however, now going into the ortho-position. Similar changes are brought about when these nitrogen chlorides are warmed with water or dilute acids.

If, however, both the para- and ortho-positions in the phenyl nucleus are occupied, *e.g.*, by chlorine atoms, no intramolecular change ensues, but the molecule breaks down in a somewhat complicated way which apparently depends on the nature of the acid radicle attached to the nitrogen; in the case of the formyl and acetyl derivatives, chlorine is set free; with the benzoyl compound, benzoyl chloride is evolved. Phenyl acetyl nitrogen chloride has been prepared by the bicarbonate method, a theoretical yield being obtained; it crystallises in large, transparent plates.

The following compounds have been prepared:—

Phenyl formyl nitrogen chloride, $\text{HCON}(\text{C}_6\text{H}_5)\cdot\text{Cl}$, long, transparent prisms. M. p. 47° . *Para-chlor-phenyl formyl nitrogen chloride*, $\text{HCON}(\text{C}_6\text{H}_4\text{Cl})\cdot\text{Cl}$, long, transparent prisms. M. p. $95-96^\circ$. *2:4-dichlor-phenyl formyl nitrogen chloride*, $\text{HCON}(\text{C}_6\text{H}_3\text{Cl}_2)\cdot\text{Cl}$, colourless, transparent plates. M. p. 44° . *Para-chlor-phenyl acetyl nitrogen chloride*, $\text{CH}_3\text{CON}(\text{C}_6\text{H}_4\text{Cl})\cdot\text{Cl}$, colourless plates. M. p. 82° . *2:4-dichlor-phenyl acetyl nitrogen chloride*, $\text{CH}_3\text{CON}(\text{C}_6\text{H}_3\text{Cl}_2)\cdot\text{Cl}$, large, glittering plates. M. p. 68° . *Phenyl benzoyl nitrogen chloride*, $\text{C}_6\text{H}_5\text{CON}(\text{C}_6\text{H}_5)\cdot\text{Cl}$, colourless plates. M. p. 77° . *2:4-dichlor-benzoyl nitrogen chloride*, $\text{C}_6\text{H}_5\text{CON}(\text{C}_6\text{H}_3\text{Cl}_2)\cdot\text{Cl}$, large, colourless plates. M. p. 86° .

We believe that the oil obtained by Witt, and regarded by him as a hypochlorous acid addition product of 2:4-dichlor-acetanilide, is impure 2:4-dichlor-phenyl acetyl nitrogen chloride.

ADDITIONS TO THE LIBRARY.

I. Donations.

Berthelot, M. *Chimie végétale et agricole*. (Station de chimie végétale de Meudon, 1883—1899.) 4 vols. Paris. 1899.

From the Author.

Clowes, F. *A Treatise on Practical Chemistry and Qualitative Analysis*. Seventh edition. London. 1899.

From the Author.

Furnival, W. J. Researches on Leadless Glazes. Stone. 1899.

From the Author.

Murrill, P. I. Alkaloidal Estimation. A Bibliographical Index of Chemical Research prepared from original literature for the Committee of Revision. (Committee of Revision and Publication of the Pharmacopoeia of the United States of America, 1890—1900.) Ann Arbor. 1898.

From the Editor.

Richter, V. von. Edited by R. Anschütz. Organic Chemistry. Vol. I. Chemistry of the Aliphatic Series. Translated by E. F. Smith. Third American from eighth German edition. London. 1899.

From the Publishers.

II. *By Purchase.*

Dupont, J., et Freundler, P. Manual opératoire de chimie organique. Paris. 1898.

Jørgensen, A. Les Microorganismes de la Fermentation. Traduit par P. Freund, et révisé par l'auteur. Deuxième édition française. Paris. 1899.

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Thomson, J. J. The Discharge of Electricity through Gases. London. 1898.

Traube, J. Physico-Chemical Methods: Translated by W. L. Hardin. Philadelphia. 1898.

At the next meeting, on Thursday, June 15th, there will be a ballot for the election of Fellows, and the following papers will be communicated by the authors:—

“On the decomposition of chlorates, with special reference to the evolution of chlorine and oxygen.” By W. H. Sodeau, B.Sc.

“The action of hydrogen peroxide on formaldehyde.” By A. Harden, M.Sc., Ph.D.

“Homocamphoronic and camphononic acids.” By A. Lapworth and E. M. Chapman.

“Action of silver compounds on α -dibromocamphor.” By A. Lapworth.

“The colouring matter of cotton flowers.” By A. G. Perkin.

“Experiments on the synthesis of camphoric acid.” By H. A. Auden, W. H. Perkin, jun., and J. L. Rose.

“Methylisoamylsuccinic acid. Part I.” By W. T. Lawrence.

PROCEEDINGS
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June 15th, 1899. Professor T. E. Thorpe, F.R.S., President, in the Chair.

Messrs. A. R. Foulerton, S. B. Schryver, and J. P. de Castro were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. Percy Kay, 3, Phene Street, Chelsea, S.W. ; Hugh Main, 45, The Vicarage, Old Charlton, Kent.

A ballot for the election of Fellows was held, and the following were subsequently declared duly elected:—Robert Henry Aders, George Dekeyne Atkinson, Percy Bean, Walter Lionel Blackman, Wilfred Carpmael, James Connah, B.Sc., Henry Meldola Danziger, Frederick Doyle, Frederick Charles Dunscombe, William Frederick Eichenauer, F. N. Ashcroft Fleischmann, William Gordon Fraser, Frederick Hutton Getman, Julius Hübner, Edward Charles Johnson, Arthur Alexander Leon, James McAlley, Robert McClumpha, George Alfred Parkes, Stanley John Peachey, Eskricke Sidney Phillips, B.A., Sidney Rossiter, Henry Royal-Dawson, William F. John Shephard, John William Shepherd, B.Sc., Charles Simmonds, B.Sc., John Ward Stainer, Samuel Stansfield, B.Sc., George Hardstaff West, B.Sc., Christopher Joseph Whittaker.

Of the following papers, those marked * were read:—

*84. "On the decomposition of chlorates, with special reference to the evolution of chlorine and oxygen." By W. H. Sodeau, B.Sc.

Some chlorates, on being heated, give off almost all their chlorine as such, whilst other chlorates give none. According to Schulze,

the chlorate breaks up into chloride and oxygen, the chlorine evolved being due to the nascent oxygen attacking the chloride, whilst Spring and Prost regard the chlorate as decomposing into oxide, chlorine, and oxygen, the chlorine being more or less reabsorbed. The author points out that in addition to these two theories two others are possible, (1) that chlorates may break up in both of these ways simultaneously, and (2) that chloride and oxide may represent the balanced action of chlorine and oxygen.

His experiments have been made chiefly with potassium and barium chlorates. The former gives no chlorine, whether the pressure of the evolved gas be kept at 1 mm. or at 1 atmosphere. With barium chlorate, however, 0.066 per cent. of the total chlorine was evolved when the pressure was kept at 1 to 2 mm. and the duration of the experiment 233 minutes, whilst at atmospheric pressure, 0.093 was obtained when the duration was 165 minutes, but when very rapidly decomposed (half a minute), the percentage of chlorine evolved rose to 0.705. These are the averages of several experiments.

From the results of his experiments, the author concluded that when barium chlorate is heated, it undergoes two decompositions at the same time: (a) an exothermic decomposition into chloride and oxygen, (b) an endothermic decomposition into oxide, chlorine, and oxygen, and that no appreciable reaction takes place between the chloride and oxygen (or chlorate), or between the oxide and chlorine, but that the increase of chlorine in a rapid decomposition may be ascribed to the great rise of temperature favouring the endothermic reaction. He believed that potassium chlorate decomposed directly into chloride and oxygen. Further experiments were being conducted on the behaviour of manganese oxides with potassium chlorate, and on the decomposition of pure lead and calcium chlorates. The experiments already performed with these chlorates appeared to confirm the author's view that these two independent reactions occurred.

***85. "Action of hydrogen peroxide on formaldehyde." By A. Harden, M.Sc., Ph.D.**

When solutions of hydrogen peroxide and formaldehyde are mixed, no reaction appears to take place, but when the liquid is made strongly alkaline with soda, hydrogen is evolved. The reaction occurs according to the equation $\text{H}_2\text{O}_2 + 2\text{CH}_2\text{O} + 2\text{NaOH} = 2\text{H} \cdot \text{CO}_2\text{Na} + \text{H}_2 + 2\text{H}_2\text{O}$. Hydrogen peroxide, therefore, when treated with alkaline formaldehyde, gives a volume of hydrogen exactly equal to the volume of oxygen which it would give with potassium permanganate and sulphuric acid.

The reaction proceeds slowly and incompletely unless a large excess

of alkali be present. When hydrogen peroxide is treated with excess of formaldehyde, the reaction takes place rapidly and completely, and the hydrogen which is evolved is pure. When, on the other hand, formaldehyde is treated with excess of hydrogen peroxide, the reaction is incomplete and proceeds very slowly, whilst the gas evolved contains oxygen. Hence the reaction does not appear adapted for the quantitative estimation of formaldehyde in aqueous solutions.

Cuprous oxide and soda give a somewhat similar reaction with formaldehyde. This reaction was described by Loew (*Ber.*, 1887, 20, 145) as a catalytic reaction, but it appears in reality to be a quantitative one, expressed by the equation $\text{Cu}_2\text{O} + 2\text{NaOH} + 2\text{CH}_2\text{O} = \text{Cu}_2 + \text{H}_2 + 2\text{H}\cdot\text{CO}_2\text{Na} + \text{H}_2\text{O}$. Cupric oxide also gives a similar reaction, two atoms of hydrogen being liberated for each atom of oxygen in the oxide.

When caustic soda and then formaldehyde are added to a solution of copper sulphate and the liquid gently warmed, the cupric hydroxide is reduced to cuprous oxide without evolution of hydrogen, and when the temperature is subsequently raised, the cuprous oxide reacts as described above. When, on the other hand, caustic soda is added to a boiling solution of copper sulphate, the liquid cooled, and formaldehyde then added, no reduction to cuprous oxide occurs on warming, but metallic copper is formed, and twice as much hydrogen is evolved as in the previous case.

Manganese dioxide does not appear to be reduced by formaldehyde, whilst the oxides of mercury and bismuth are reduced without evolution of hydrogen.

DISCUSSION.

Mr. CROSS said that he regarded the author's results as additional evidence that hydrogen peroxide tends to react as H_2O_2 , as it was clear that, in this case, it could not react as $\text{H}_2\text{O}\cdot\text{O}$.

Dr. DEBUS pointed out that, in acting as an oxidising agent, hydrogen peroxide usually broke up into water and oxygen, but since aldehydes in many reactions behave as hydrides, we might suppose that the equation $2\text{H}\cdot\text{CHO} + (\text{HO})_2 = 2(\text{HO}\cdot\text{CHO}) + \text{H}_2$ represented the change, the hydrogen set free coming from the aldehyde.

*86. "Homocamphoronic and camphoronic acids." By Arthur Lapworth and Edgar M. Chapman.

α -Dibromocamphor, though scarcely affected by the ordinary mild oxidising agents, is rapidly attacked by dilute nitric acid in presence of silver nitrate. The greater portion of the substance is reduced to monobromocamphor and camphor, but a small quantity is converted into a neutral *nitro*-compound, $\text{C}_{10}\text{H}_{14}\text{N}_2\text{O}_6$, which crystallises in beautiful,

orthorhombic prisms melting at 93—94°. A still smaller quantity of the dibromo-compound is converted into an *acid*, $C_{10}H_{16}O_6$, which is found to be identical with the substance obtained by Forster (*Trans.*, 1896, 59, 49) on oxidising bromocamphorenic acid with dilute permanganate. The authors find that this acid is tribasic, and for it they propose the name *homocamphoronic acid*; it is an open chain tricarboxylic acid, and its constitution must be represented by one of two formulæ, $CO_2H \cdot CMe_2 \cdot CMe(CO_2H) \cdot CH_2 \cdot CH_2 \cdot CO_2H$ or $CO_2H \cdot CH_2 \cdot CMe_2 \cdot CMe(CO_2H) \cdot CH_2 \cdot CO_2H$, of which the former seems to be the more probable. Homocamphoronic acid is optically active; in 2 per cent. aqueous solution $[a]_D = -34.96^\circ$. It is somewhat sparingly soluble in water, and separates from aqueous solution in small prisms which give off water and melt, according to the rate of heating, between 180° and 208°, the latter temperature being probably the true melting point. *Anhydrohomocamphoronic acid*, $CO_2H \cdot C_7H_{13} \begin{smallmatrix} \diagup CO \\ \diagdown CO \end{smallmatrix} O$, is made by heating the acid or by warming it with acetyl chloride; it crystallises in prisms melting at 86—87°. The aniline derivative, $(CO_2H)_2 \cdot C_7H_{13}CO \cdot NHPh$, melts at 98—100°, and the paratoluidine derivative, $(CO_2H)_2 \cdot C_7H_{13} \cdot CO \cdot NH \cdot C_7H_7$, at 163—164°.

When anhydrohomocamphoronic acid is heated to 200—260°, it loses carbon dioxide and yields an acid having the formula $C_9H_{14}O_3$. This substance is a saturated cyclic ketonic acid having the structure $\begin{smallmatrix} CO \cdot CMe_2 \\ | \\ CH_2 \cdot CH_2 \end{smallmatrix} \begin{smallmatrix} \diagup \\ \diagdown \end{smallmatrix} CMe \cdot CO_2H$ or $\begin{smallmatrix} CH_2 \cdot CMe_2 \\ | \\ CO \cdot CH_2 \end{smallmatrix} \begin{smallmatrix} \diagup \\ \diagdown \end{smallmatrix} CMe \cdot CO_2H$, and, therefore, containing the carbon atoms in the position assumed by Bredt and Perkin for nine of the ten atoms in camphoric acid. The substance is, in fact, identical with a ketonic acid obtained by J. Walker as a bye-product in the electrolysis of ethyl allocamphorate. Dr. Walker was good enough to send the authors a small specimen of his acid for comparison, and the identity of the two substances has been completely established; he has, moreover, agreed to the name *camphononic acid*, which the authors propose for it. It melts at 228°, and has all the properties assigned to it by Walker. The phenylhydrazone, $CO_2H \cdot C_8H_{13} \cdot N \cdot NHPh$, crystallises in colourless needles melting at 174°. The *bromophenylhydrazone*, $C_{15}H_{19}O_2N_2Br$, forms transparent prisms and melts at 194—195°. The *semicarbazone* crystallises in needles and melts and decomposes at 230—232°.

When camphononic acid is very carefully oxidised with dilute nitric acid, a large quantity of camphoronic acid, which is apparently the sole product, is obtained.

***87. "Action of silver compounds on α -dibromocamphor." By Arthur Lapworth.**

The formation of homocamphoronic acid from α -dibromocamphor by the action of dilute nitric acid and silver nitrate is preceded by the production of an unsaturated acid, $C_{10}H_{15}BrO_2$, identical with bromocamphorenic acid, which was first obtained by the reduction of α -dibromocampholid (Forster, *Trans.*, 1896, 69, 46). This substance may be obtained by heating a solution of α -dibromocamphor in acetic acid or alcohol with silver nitrate, acetate, or oxide; the amount formed is small, however (10—20 per cent.), the greater portion of the dibromocamphor undergoing reduction.

The formation of bromocamphorenic acid appears at first to be due to hydrolysis, represented empirically by the equation $C_{10}H_{14}Br_2O + H_2O = C_{10}H_{15}BrO_2 + HBr$. As bromocamphorenic acid at once loses hydrogen bromide when treated with cold dilute potassium permanganate, and is subsequently converted into homocamphoronic acid, it seems certain that it contains the group $-CH=CHBr-$ as a part of the closed chain; and as dibromocamphor contains the group $-CHBr \cdot CO-$, it would appear that, in the formation of bromocamphorenic acid, these two carbon atoms are separated, and that one of them enters the second pentamethylene ring. Of the possible formulæ for bromocamphorenic acid, which are, of course, easily derived from the two possible formulæ for homocamphoronic acid (see preceding note) the formula $CH \begin{smallmatrix} \diagup CBr \cdot CMe_2 \\ \diagdown CH_2 \cdot CH_2 \end{smallmatrix} > CMe \cdot CO_2H$ is the one which is most in accordance with the facts which have been observed, the corresponding formula

for dibromocampholid being $CHBr \begin{smallmatrix} \diagup CBr \cdot CMe_2 \\ \diagdown O-CO \\ \diagdown CH_2-CH_2 \end{smallmatrix} > CMe$.

88. "The colouring matter of cotton flowers." By A. G. Perkin.

The flowers of the cotton plant, *Gossypium herbaceum*, are employed as a dyestuff in the Manipur district of India. They contain as glucoside a new colouring matter, *gossypetin*, $C_{16}H_{12}O_8$, soluble in alkalis with an orange-red colour, becoming green on oxidation. The *hexacetyl* compound, $C_{16}H_6O_8Ac_6$, colourless needles, m. p. 212—216°; the *sulphate*, $C_{16}H_{12}O_8 \cdot H_2SO_4$, the *hydriodide*, $C_{16}H_{12}O_8 \cdot HI$, orange-red needles, and the *monopotassium* salt, $C_{16}H_{11}O_8K$, a crystalline powder, have been prepared. *Gossypetin* contains no methoxyl groups, and on fusion with alkali yields phloroglucinol and protocatechuic acid. It is probably a member of the flavone group of colouring matters. *Gossypetin* is similar to, but not identical with, *thujetin*, which is present in *Thuja occidentalis* (Kawaler, *Jahresbericht*, 1858, 512).

Note on Rottlerine.—The decomposition products of rottlerine, $C_{33}H_{30}O_9$, a colouring matter of kamala, *Mallotus Phillipinensis*, previously described (*Trans.*, 1893, 65, 981; 1895, 67, 230), are with fused alkali acetic and benzoic acids, and with nitric acid *o*- and *p*-nitrocinnamic acids. It has now been found that fused alkali at 220—240° yields also phloroglucinol.

39. "Experiments on the synthesis of camphoric acid." By H. A. Auden, W. H. Perkin, jun., and J. L. Rose.

These experiments were instituted with the object of preparing an acid of the formula
$$\begin{array}{ccc} CO_2H \cdot \overset{*}{C}OH \cdot Me & H \overset{*}{C}(Me)_2 & \\ | & | & \\ CO_2H \cdot CH-CH_2- & CH_2 & \end{array}$$
 in the hope that it

might prove possible to eliminate water between the points marked *, and thus obtain an acid,
$$\begin{array}{ccc} CO_2H \cdot C(Me)- & C(Me)_2 & \\ | & | & \\ CO_2H \cdot CH \cdot CH_2 \cdot & CH_2 & \end{array}$$
 which would have

the constitution first suggested by Perkin (*Proc.*, 1896, 12, 191) as a possible expression of the constitution of camphoric acid. Ethyl isoamylacetoacetate was dissolved in ether and treated at a low temperature with potassium cyanide and hydrochloric acid, when ethyl α -isoamyl- $\beta\beta$ -hydroxycyanobutyrate, $Me(CN)C(OH) \cdot CH(C_5H_{11}) \cdot CO_2Et$, was obtained as a thick oil, which, on hydrolysis with alcohol and hydrochloric acid, yielded as principal product methylhydroxyisoamylsuccinimide,
$$\begin{array}{c} Me \cdot C(OH) \cdot CO \\ | \\ C_5H_{11} \cdot CH-CO \end{array} > NH \text{ (m. p. } 104^\circ \text{)}$$

This substance, when boiled with sodium carbonate, is first converted into the corresponding amide, which crystallises from water and melts at 183°, and then into $\alpha\alpha$ -methylhydroxy- α' -isoamylsuccinic acid,
$$\begin{array}{c} Me \cdot C(OH) \cdot CO_2H \\ | \\ C_5H_{11} \cdot CH-CO_2H \end{array}$$
 which melts at 66°, and yields a silver salt

of the formula $C_{10}H_{16}O_5Ag_2$. As this acid has the constitution represented by the formula given at the commencement of this abstract, experiments were next made with the object of eliminating water in such a way as to obtain a saturated acid of the same composition as camphoric acid, but without success. When the acid is subjected to distillation, water is eliminated and an oil, distilling at 260°, is obtained, which, after careful investigation, has been found to be methyl-

isoamylmaleic anhydride,
$$\begin{array}{c} Me \cdot C \cdot CO \\ || \\ C_5H_{11} \cdot C \cdot CO \end{array} > O$$
. This anhydride dissolves

in potash solution, but on acidifying, the anhydride, and not the acid, separates, a behaviour which is exactly similar to the case of xeronic acid,
$$\begin{array}{c} Et \cdot C \cdot CO_2H \\ || \\ Et \cdot C \cdot CO_2H \end{array}$$
 which, when set free from its salts, is obtained in the form of its anhydride.

The solution of methylisoamylmaleic anhydride in benzene gives, with aniline, the anil $C_{16}H_{19}O_2N$, which crystallises from methyl alcohol and melts at 70° . When the anhydride is reduced with hydriodic acid and phosphorus, it yields a mixture of *cis*- and *trans*-methylisoamylsuccinic acids, $\begin{matrix} \text{Me} & \text{---} & \text{CH} \cdot \text{CO}_2\text{H} \\ & & | \\ C_5H_{11} & \cdot & \text{CH} \cdot \text{CO}_2\text{H} \end{matrix}$, the former of which melts at 92° and the latter at 142° (see following abstract).

Ethyl isoamylacetoacetate is readily reduced by sodium amalgam, forming α -isoamyl- β -hydroxybutyric acid, $\text{Me} \cdot \text{CHOH} \cdot \text{CH}(C_5H_{11}) \cdot \text{CO}_2\text{Et}$, a thick oil, which, on distillation, decomposes with elimination of water and formation of α -isoamylcrotonic acid, $\text{Me} \cdot \text{CH} : \text{C}(C_5H_{11}) \cdot \text{CO}_2\text{H}$ (b. p. 240°). That ring-formation had not taken place in this case was shown by the fact that the acid obtained is unsaturated, and, on oxidation, yields isobutylic acid, $C_4H_8O_2$. When isoamylacetone, $C_5H_{11} \cdot \text{CH}_2 \cdot \text{CO} \cdot \text{Me}$, is treated with hydrocyanic acid and the product hydrolysed, a small quantity of α -hydroxy- β -isoamylisobutyric acid, $C_5H_{11} \cdot \text{CH}_2 \cdot \text{C}(\text{OH})(\text{Me}) \cdot \text{CO}_2\text{H}$, is formed, which melts at 66° , and is isomeric with the isoamylhydroxybutyric acid mentioned above.

90. "Methylisoamylsuccinic acid. I." By W. Trevor Lawrence.

The author is preparing methylisoamylsuccinic acid in large quantities, in order to obtain from it, if possible, by oxidation or bromination and subsequent splitting off of water or hydrogen bromide respectively, an acid possessing the constitution of camphoric acid (see preceding abstract) suggested by Perkin in 1896, and independently in 1897 by Bouveault (*Bull. Soc. Chim.*, iii, 17, 990); this paper contains only such results as confirm those of Auden, Perkin, and Rose.

When ethyl α -methyl- α' -cyansuccinate, isoamylbromide, and sodium ethylate are heated, in molecular proportions, and the product of the condensation distilled under diminished pressure, ethyl α -methyl- α' -cyan- α' -isoamylsuccinate, $\text{CO}_2\text{EtC}(C_5H_{11})(\text{CN}) \cdot \text{CH}(\text{Me})\text{CO}_2\text{Et}$, is obtained (b. p. 182° , 30 mm.), which, on hydrolysis with alcoholic potash, gives after acidifying, a semi-solid acid mass, probably consisting of the cyansuccinic acid. A similar acid was also prepared as follows:

Isoamylacetic acid is converted by bromine and phosphorus pentabromide into the acid bromide of α -bromisoamylacetic acid, which, with alcohol, gives ethyl α -bromisoamylacetate, $C_5H_{11}\text{CHBr}(\text{CO}_2\text{Et})$, (b. p. 146° , 65 mm.); this condenses with ethyl sodiocyanacetate to form ethyl α -cyan- α' -isoamylsuccinate (b. p. 196° , 35 mm.).

Ethyl α -cyan- α' -isoamylsuccinate, $\text{CO}_2\text{Et} \cdot \text{CH}(\text{CN}) \cdot \text{CH}(C_5H_{11})(\text{CO}_2\text{Et})$, is converted into isoamylsuccinic acid, $(\text{CO}_2\text{H}) \cdot \text{CH}_2 \cdot \text{CH}(C_5H_{11})\text{CO}_2\text{H}$,

(m. p. 76°), on hydrolysis, and is identical with the acid obtained by Fittig and Schirmacher (*Annalen*, 1898, 304, 295)—on treatment with methyl iodide and sodium ethylate, it is converted into ethyl α -cyan- α -methyl- α' -isoamylsuccinate, $\text{CO}_2\text{Et} \cdot \text{C}(\text{CN})(\text{Me}) \cdot \text{CH}(\text{C}_5\text{H}_{11})\text{CO}_2\text{Et}$, (b. p. 185° , 30 mm.), which, on hydrolysis, gives a similar cyansuccinic acid to the one mentioned above.

Both of these cyan-acids give, on hydrolysis, a mixture of *trans*- and *cis*-methylisoamylsuccinic acids, $\text{CO}_2\text{H} \cdot \text{CH}(\text{Me}) \cdot \text{CH}(\text{C}_5\text{H}_{11})(\text{CO}_2\text{H})$, which may be separated either by distillation in a current of steam, in which the *cis*-acid is volatile, or by means of ligroin, in which the *trans*-acid is insoluble.

trans-Methylisoamylsuccinic acid crystallises from benzene or hot water in prisms (m. p. 141 — 142°), and is converted by acetyl chloride into the anhydride (b. p. 170° , 25 mm.).

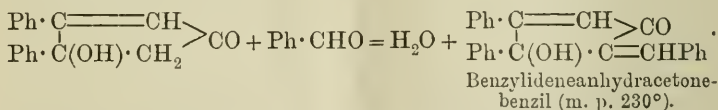
cis-Methylisoamylsuccinic acid is not easily recrystallised; it is obtained from the pure anhydride as a crystalline powder (m. p. 93°); the anhydride is obtained as an oil (b. p. 187° , 50 mm.) by the action of acetyl chloride. The anil melts at 116° .

This anhydride, heated with bromine and chloroform in a sealed tube for ten hours, is converted into β -isoamylcitraconic anhydride, $\text{C}_5\text{H}_{11}\text{C}(\text{Me})\text{CO} \cdot \text{CO} \cdot \text{C}(\text{Me})\text{C}_5\text{H}_{11}$, an oil (b. p. 170° , 50 mm.); the free acid does not appear to exist.

On treatment with aniline, the anhydride, which reduces permanganate in the cold, is converted into the characteristic anil, which crystallises from methyl alcohol in needles, (m. p. 71°).

91. "Condensations of anhydracetonebenzil and its analogues with aldehydes." By Francis R. Japp, F.R.S., and Alexander Findlay, M.A., B.Sc.

The authors find that anhydracetonebenzil (diphenylcyclopentenolone) and benzaldehyde interact in presence of alcoholic potash according to the equation



In like manner, by acting on anhydracetonebenzil with cuminaldehyde, they obtained *cumylideneanhydracetonebenzil*, $\text{C}_{27}\text{H}_{24}\text{O}_2$ (m. p. 148°); and with cinnamaldehyde, *cinnamylideneanhydracetonebenzil*, $\text{C}_{26}\text{H}_{20}\text{O}_2$ (m. p. 222°).

By reduction with hydriodic acid, benzylideneanhydracetonebenzil

yields a compound $C_{24}H_{18}O$ (m. p. 182°)—probably a *benzylidene-diphenylcyclopentenone*.

The authors have applied the interaction with benzaldehyde to determining the constitution of the monosubstitution derivatives of anhydracetonebenzil, in which there is a doubt as to whether the substitution occurs in the CH - or in the CH_2 -group. The condensation cannot occur except in the case of derivatives containing the CH_2 -group intact. Thus Japp and Lander assigned to the

monalkyl derivatives the formula $\frac{Ph \cdot C \equiv CH}{Ph \cdot C(OH) \cdot CHR'} > CO$, and in accordance with this, it was found that amylanhydracetonebenzil does not

interact with benzaldehyde. On the other hand, α -anhydrobenzil-lævulic (α -anhydracetonebenzilethyloic) acid, in accordance with the formula ascribed to it by Japp and Murray, gives *benzylidene- α -anhydro-*

benzillævulic acid, $\frac{Ph \cdot C \equiv C - CH_2 \cdot CO_2H}{Ph \cdot C(OH) \cdot C \equiv CHPh} > CO$ (m. p. $214-216^\circ$). Anhydr-

acetonebenzilcarboxylic acid, however, must have the constitution

$\frac{Ph \cdot C \equiv C - CO_2H}{Ph \cdot C(OH) \cdot CH_2} > CO$, instead of the alternative constitution

adopted for it by Japp and Lander, inasmuch as it yields a benzylidene derivative, $C_{25}H_{18}O_4$ (m. p. about 245°).

Anhydracetonebenzil and benzil interact in presence of alcoholic

potash to form an aldol condensation compound, $\frac{Ph \cdot C \equiv CH}{Ph \cdot C(OH) \cdot CH} > CO$
 $Ph \cdot CO \cdot C(OH) \cdot Ph$

(m. p. 200°), identical with anhydracetonedibenzil, previously obtained by the condensation of acetone with excess of benzil (*Trans.*, 1885, 47, 33). The hitherto unknown constitution of anhydracetonedibenzil is thus ascertained.

92. "Triphenyloxazolone." By Francis R. Japp, F.R.S., and Alexander Findlay, M.A., B.Sc.

By the action of cold concentrated sulphuric acid on a mixture of benzonitrile and benzilic acid, the authors have obtained *triphenyl-oxazolone* (triphenylketodihydro-oxazole), $Ph \cdot CN + \frac{C(OH)Ph_2}{CO_2H} =$

$Ph \cdot C \begin{smallmatrix} \diagup O \\ \diagdown N \end{smallmatrix} \begin{smallmatrix} \diagup CPh_2 \\ \diagdown CO \end{smallmatrix} + H_2O$. It crystallises in large, transparent rhombs

melting at 136° . At the same time, *benzimidoxydiphenylacetic acid*, $Ph \cdot C(NH) \cdot O \cdot CPh_2 \cdot CO_2H$, is formed, which is deposited from its solutions in prisms or plates melting at 190° .

Heating with acetic anhydride converts the acid into the oxazolone,

whilst boiling with *dilute* potash transforms the oxazolone into a salt of the acid.

When the acid is heated with *strong* potash, it parts with carbon dioxide, and yields *benzimidobenzhydrylic oxide*, $\text{Ph} \cdot \text{C}(\text{NH}) \cdot \text{O} \cdot \text{CHPh}_2$ (needles, m. p. 172—173°). The constitution of the latter compound was proved by its synthesis from benzonitrile and benzhydrol under the influence of gaseous hydrogen chloride. It thus belongs to the class of imido-ethers described by Pinner and Klein (*Ber.*, 1877, 10, 1889).

Both the oxazolone and the acid, when boiled for a few minutes with fuming hydriodic acid, yield benzamide and diphenylacetic acid. Under the same conditions, benzimidobenzhydrylic oxide gives diphenylmethane in place of diphenylacetic acid.

None of the other nitriles and α -hydroxy-acids with which the authors experimented yielded compounds corresponding with the foregoing.

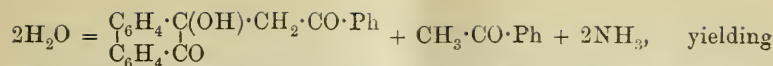
93. "Interaction of phenanthraquinone, acetophenone, and ammonia." By Francis R. Japp, F.R.S., and Andrew N. Meldrum, B.Sc.

Japp and Streatfield showed (*Trans.*, 1882, 41, 270) that phenanthraquinone, acetone, and ammonia interact according to the equation $\text{C}_{14}\text{H}_8\text{O}_2 + \text{C}_3\text{H}_6\text{O} + \text{NH}_3 = \text{C}_{17}\text{H}_{15}\text{NO}_2 + \text{H}_2\text{O}$, and to the compound thus formed the constitution $\begin{array}{c} \text{C}_6\text{H}_4 \cdot \text{C}(\text{OH}) \cdot \text{CH}_2 \cdot \text{Ac} \\ | \\ \text{C}_6\text{H}_4 \cdot \text{C} \cdot \text{NH} \end{array}$ was assigned

by Japp and Miller (*Trans.*, 1885, 47, 12). The results of the present investigation, however, render the constitution $\begin{array}{c} \text{C}_6\text{H}_4 \cdot \text{C}(\text{NH}_2) \cdot \text{CH}_2 \cdot \text{Ac} \\ | \\ \text{C}_6\text{H}_4 \cdot \text{CO} \end{array}$, analogous to that of diacetonamine, more probable. The compound may be named *acetonylamino-phenanthrene*.

Thus the authors find that phenanthraquinone, acetophenone and alcoholic ammonia interact according to the equation $\begin{array}{c} \text{C}_6\text{H}_4 \cdot \text{CO} \\ | \\ \text{C}_6\text{H}_4 \cdot \text{CO} \end{array} + 2\text{CH}_3 \cdot \text{CO} \cdot \text{Ph} + 2\text{NH}_3 = \begin{array}{c} \text{C}_6\text{H}_4 \cdot \text{C}(\text{NH}_2) \cdot \text{CH}_2 \cdot \text{CO} \cdot \text{Ph} \\ | \\ \text{C}_6\text{H}_4 \cdot \text{C}(\text{NH}_2) \cdot \text{CH}_2 \cdot \text{CO} \cdot \text{Ph} \end{array} + 2\text{H}_2\text{O}$, yielding *diphenacyldiaminodihydrophenanthrene*, which crystallises in colourless, silky needles, and decomposes about 150° without showing a definite melting point. It is evident that a constitution analogous to that ascribed by Japp and Miller to the acetone-ammonia derivative of phenanthraquinone is not possible in the case of this compound.

The acetophenone-ammonia derivative is hydrolysed by aqueous oxalic acid according to the equation $\begin{array}{c} \text{C}_6\text{H}_4 \cdot \text{C}(\text{NH}_2) \cdot \text{CH}_2 \cdot \text{CO} \cdot \text{Ph} \\ | \\ \text{C}_6\text{H}_4 \cdot \text{C}(\text{NH}_2) \cdot \text{CH}_2 \cdot \text{CO} \cdot \text{Ph} \end{array} +$



phenacylhydroxyphenanthrone (*acetophenonephenanthraquinone*), which crystallises in small prisms or six-sided plates melting, with decomposition, at 125–130°.

By the interaction of phenanthraquinone, acetophenone, and aqueous ammonia, *phenacylaminophenanthrone*, $\begin{array}{c} \text{C}_6\text{H}_4 \cdot \text{C}(\text{NH}_2) \cdot \text{CH}_2 \cdot \text{CO} \cdot \text{Ph} \\ \text{C}_6\text{H}_4 \cdot \text{CO} \end{array}$, analogous to the acetone-ammonia derivative, was obtained. It crystallises in minute, colourless, six-sided plates melting about 160° with decomposition and evolution of gas. A substance, apparently identical with the foregoing, was obtained by the action of ammonia on phenacylhydroxyphenanthrone.

The ease with which these compounds break up into their generating substances renders a detailed study of their constitution impossible.

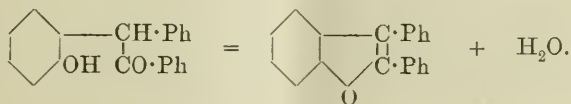
Other ketones, such as methyl ethyl ketone and diethyl ketone, appeared to interact in a similar manner with phenanthraquinone and ammonia; but it was found impossible to obtain the resulting compounds in a state of purity.

94. "Furfuran derivatives from benzoin and phenols." By Francis R. Japp, F.R.S., and Andrew N. Meldrum, B.Sc.

By the action of cold, concentrated sulphuric acid on a mixture of benzoin and phenol, Japp and Wadsworth (*Trans.*, 1890, 58, 965) obtained *paradesylphenolsulphonic acid*, from which, by hydrolysing it with strong hydrochloric acid at 150°, *paradesylphenol*, $\begin{array}{c} \text{Ph} \cdot \text{CH} \cdot \text{C}_6\text{H}_4 \cdot \text{OH} \\ \text{Ph} \cdot \text{CO} \end{array}$ (1 : 4), was prepared.

The authors find that, by heating a mixture of benzoin and phenol with sulphuric acid of 73 per cent. strength, the foregoing condensation occurs without subsequent sulphonation of the resulting compound, and an excellent yield of *paradesylphenol* is obtained. The various condensations described in this note were effected by means of a sulphuric acid of this strength.

If the desyl-group were to take up the ortho-position towards the hydroxyl of the phenol, it is evident that, by a further elimination of water, a furfuran derivative might be formed :

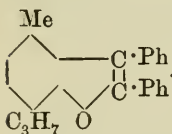


With phenol and benzoin, no such reaction occurs; the *para*-compound alone is formed. With thymol and benzoin, however, a mixture

of desylthymol and cymodiphenylfurfuran is obtained. In the case of resorcinol and of quinol, either one or two diphenylfurfuran groups may be introduced. With phloroglucinol, only the compound containing three such groups was obtained.

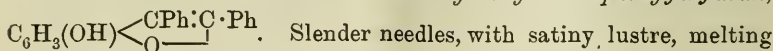
The following compounds have been prepared: (1) From thymol and benzoïn. *Desylthymol*, $\text{Ph} \cdot \text{CH} \cdot \text{C}_6\text{H}_2(\text{Me})(\text{C}_3\text{H}_7)\text{OH}$. Laminæ melting at 126°. The acetyl derivative forms needles melting at 110°.

The position of the desyl group in desylthymol is uncertain, except that it is not adjacent to the hydroxyl group. *Cymodiphenylfurfuran*,



Slender needles melting at 115—116°. (2) From

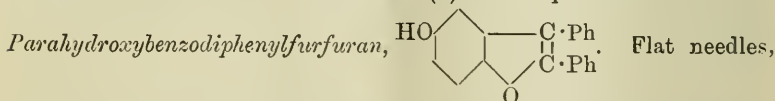
resorcinol and benzoïn. *Metahydroxybenzodiphenylfurfuran*,



Slender needles, with satiny lustre, melting at 117.5°. The acetyl derivative crystallises in slender prisms, melting at 117°. The practical coincidence in the melting points of these two substances is anomalous. They differ greatly in their other physical properties.

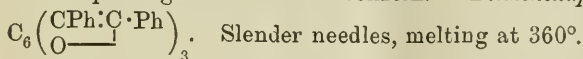
Metabenzotetraphenyldifurfuran, $\text{C}_6\text{H}_2\left(\frac{\text{CPh} \cdot \text{C} \cdot \text{Ph}}{\text{O}}\right)_2$.

Slender needles, melting at 217—219°. Solutions show a violet fluorescence. Two constitutions, between which it is at present impossible to decide, might be assigned to each of these derivatives. Isomeric forms were not observed. (3) From quinol and benzoïn.



melting at 158—160°. The acetyl derivative forms laminæ melting at 137°. *Parabenzotetraphenyldifurfuran*, $\text{C}_{34}\text{H}_{22}\text{O}_2$. Constitution analogous to that of the corresponding resorcinol derivative. Only one of the two possible isomerides observed. Needles melting at 278°. Solutions strongly fluorescent; crystals slightly so. (4)

From phloroglucinol and benzoïn. *Benzohexaphenyltrifurfuran*,



The foregoing work was completed last year, before the publication of Graebe's investigation of benzoïn yellow (*Ber.*, 1898, 31, 2975), in which it is shown that, by the action of sulphuric acid on a mixture of benzoïn and gallic acid, a compound containing a diphenylfurfuran group is formed.

95. "Interaction of benzoin with phenylenediamines." By Francis R. Japp, F.R.S., and Andrew N. Meldrum, B.Sc.

By heating benzoin with aniline and a little aniline hydrochloride, Japp and Murray (*Trans.*, 1894, 65, 892) obtained 2':3'-diphenylindole. The desylanilide, $\text{Ph}\cdot\text{CO}\cdot\text{CH}(\text{NH}\cdot\text{Ph})\cdot\text{Ph}$, which is formed in the first instance, parts with water, under the influence of the hydrochloric acid, yielding the indole. The authors have now studied this reaction with the phenylenediamines, in order, if possible, to obtain the corresponding benzodipyrrole derivatives. Only in the case of meta-phenylenediamine, however, did the reaction take place in the desired sense.

Benzoin, heated with metaphenylenediamine and a little of its hydrochloride, gave *metabenzotetraphenyldipyrrole*, $\text{C}_6\text{H}_2\left(\text{CPh}\cdot\text{C}\cdot\text{Ph}\right)_2$, which forms slender needles melting at 282° . Two constitutions are possible for this compound, and at present there is apparently no means of deciding between them. Substituting paraphenylenediamine and its hydrochloride for the meta-compounds in the foregoing reaction, *bidesylparaphenylenediamine*, $\text{C}_6\text{H}_4(\text{NH}\cdot\text{CHPh}\cdot\text{CO}\cdot\text{Ph})_2$, was obtained in the form of bright yellow, minute laminae melting at 257° . It yields a diacetyl derivative crystallising in slender, colourless needles melting at 279° . By heating either bidesylparaphenylenediamine or its diacetyl derivative with zinc chloride, or by heating benzoin with paraphenylenediamine hydrochloride alone, indications of the formation of a benzodipyrrole derivative were obtained; but the compound was not formed in quantity sufficient to admit of its purification.

By heating benzoin with orthophenylenediamine hydrochloride, *phenylbenzimidazole*, $\text{C}_6\text{H}_4\left\langle\begin{smallmatrix} \text{NH} \\ \text{---} \end{smallmatrix}\right\rangle\text{C}\cdot\text{Ph}$, was obtained, the benzoin molecule breaking up in the process. Benzoin and free orthophenylenediamine, on the other hand, yielded *diphenylquinoxaline*, $\text{C}_6\text{H}_4\left\langle\begin{smallmatrix} \text{N}\cdot\text{C}\cdot\text{Ph} \\ \text{N}\cdot\text{C}\cdot\text{Ph} \end{smallmatrix}\right\rangle$, oxidation taking place during the process. The formation of the latter compound in this reaction had, as we afterwards found, been already observed by O. Fischer (*Ber.*, 1891, 24, 720).

96. "The condensation of ethyl salts of acids of the acetylene series with ketonic compounds." By Siegfried Ruhemann and A. V. Cunningham.

The substitution products of ethyl phenylpropiolate, *e.g.*, ethyl *p*-nitrophenylpropiolate, on treatment with sodium ethoxide, yield, with ethyl acetoacetate and ethyl benzoylacetate respectively, the nitro-

substituted cyclic compounds corresponding to the α -pyrone derivatives previously described. The homologues of ethyl acetoacetate, however, on treatment with ethyl phenylpropiolate and sodium ethoxide, give rise to a mixture of compounds which the authors were unable to separate by fractional distillation. The α -pyrone derivatives obtained from β -diketones, like those from ethyl salts of β -ketonic acids, can be transformed into pyridine derivatives. Thus diphenylaceto- α -pyrone

CH—COH
yields $\text{PhC} \begin{array}{c} \diagup \\ \diagdown \end{array} \begin{array}{c} \diagdown \\ \diagup \end{array} \text{N} \begin{array}{c} \diagup \\ \diagdown \end{array} \begin{array}{c} \diagdown \\ \diagup \end{array} \text{C} \begin{array}{c} \diagup \\ \diagdown \end{array} \begin{array}{c} \diagdown \\ \diagup \end{array} \text{Ph}$ (m. p. 255°). The intermediate product of

this reaction, *i.e.*, the ethyl salt, $\text{CO}_2\text{Et} \cdot \text{CH} \cdot \text{CPh} \cdot \text{CAc} \cdot \text{CPh}(\text{NH}_2)$ (m. p. 161—162°), was isolated.

It was further found that ethylamine, like ammonia, yields, with α -pyrone derivatives, additive compounds with two molecules of the amine. The behaviour of ethyl acetylenedicarboxylate differs from that of ethyl phenylpropiolate towards the ethyl salts of benzoylacetic and acetoacetic acids. In these cases, α -pyrone derivatives are not produced, but compounds which are most probably trimethylene

derivatives, such as $\text{CO}_2\text{Et} \cdot \text{CH} \cdot \text{CH} \cdot \text{CO}_2\text{Et}$
Bz·C·CO₂Et, a yellow oil with green

fluorescence, b. p. 236—237° at 11 mm., and $\text{CO}_2\text{Et} \cdot \text{CH} \cdot \text{CH} \cdot \text{CO}_2\text{Et}$
Ac·C·CO₂Et

a colourless oil, b. p. 186—187, at 13 mm.

97. "Dextro-ac-tetrahydro- β -naphthylamine." By William Jackson Pope.

The only amido-derivative of tetrahydronaphthalene which has previously been resolved into optically active components is ac-1:4'-tetrahydronaphthylenediamine; this base was resolved by Bamberger (*Ber.*, 1890, 23, 291) by crystallising its acid tartrates.

On adding a solution of half a molecular proportion of ammonium dextro- α -bromocamphorsulphonate to a hot aqueous solution of synthetic ac-tetrahydro- β -naphthylamine hydrochloride, and allowing to cool, a copious separation of *dextro-ac-tetrahydro- β -naphthylamine dextro- α -bromocamphorsulphonate*, $\text{C}_{10}\text{H}_{11}\text{NH}_2 \cdot \text{C}_{10}\text{H}_{14}\text{BrOSO}_3\text{H}$, occurs; this salt is very sparingly soluble in water, but crystallises from a mixture of alcohol and acetone in long, colourless needles melting at 185—187°, and in a 5 per cent. solution in absolute alcohol has the specific rotation $[\alpha]_D = +78^\circ$.

Dextro-ac-tetrahydro- β -naphthylamine, $\begin{array}{c} \text{CH} \cdot \text{CH} \cdot \text{C} \cdot \text{CH}_2 \cdot \text{CH}_2 \\ | \quad | \quad | \quad | \\ \text{CH} \cdot \text{CH} \cdot \text{C} \cdot \text{CH}_2 \cdot \text{CH} \cdot \text{NH}_2 \end{array}$, is

obtained as a colourless oil on treating its dextrobromocamphorsulphonate with soda, extracting repeatedly with ether, and distilling under reduced pressure. It has the specific rotation $[\alpha]_D = +31^\circ$ at 15° in a 16 per cent. solution in benzene. The *dextrocamphorsulphonate*, $C_{10}H_{11}NH_2 \cdot C_{10}H_{14}OSO_3H$, obtained by treating the dextro-base by Reychler's dextrocamphorsulphonic acid, separates from aqueous solution in large, very lustrous, transparent crystals melting at $215-216^\circ$; it has the specific rotation $[\alpha]_D = +43.5^\circ$ in a 2 per cent. aqueous solution.

98. "The resolution of racemic tetrahydroparatoluquinaldine into its optically active components." By William Jackson Pope and Edmund Milton Rich.

The authors have obtained racemic tetrahydroparatoluquinaldine, $\begin{array}{c} CMe \cdot CH : C \cdot CH_2 \cdot CH_2 \\ | \qquad | \\ CH \cdot CH : C \cdot NH \cdot CHMe \end{array}$, described as an oil by Doebner and Miller (*Ber.*, 1883, 16, 2464), as a colourless, crystalline substance melting at 32° . It separates in large, transparent crystals from solution in light petroleum, and is almost odourless. The racemic *hydrochloride* crystallises in magnificent prisms melting at $171-173^\circ$. Racemic *benzoyltetrahydroparatoluquinaldine*, $C_{11}H_{14}NCOPh$, separates from its solution in acetone in large, colourless crystals melting at $103-104^\circ$. On adding half a molecular proportion of ammonium dextro- α -bromocamphorsulphonate in aqueous solution to a solution containing one molecular proportion of racemic tetrahydroparatoluquinaldine hydrochloride, *levotetrahydroparatoluquinaldine dextro- α -bromocamphorsulphonate*, $C_{11}H_{15}N \cdot C_{10}H_{14}BrOSO_3H$, separates as an oil which soon solidifies; it crystallises from dilute alcohol in colourless needles melting at $195-196^\circ$. *Levetetrahydroparatoluquinaldine*, $C_{11}H_{15}N$, is obtained as a colourless, crystalline mass on treating its dextrobromocamphorsulphonate with dilute soda. It separates from its solution in light petroleum in long, colourless, transparent prisms melting at $52-53^\circ$ having a scarcely perceptible quinoline-like odour; in a 2 per cent. solution in benzene at 21° , it has the specific rotation $[\alpha]_D = -80.9^\circ$ and the molecular rotation $[M]_D = -130.2^\circ$. The *hydrochloride* crystallises in magnificent, colourless crystals melting at $192-194^\circ$, and in a 2 per cent. aqueous solution at 18° has the specific rotation $[\alpha]_D = -68.7^\circ$ and the molecular rotation $[M]_D = -135.3^\circ$. *Benzoyllevotetrahydroparatoluquinaldine*, $C_{11}H_{14}NCOPh$, crystallises from alcohol in colourless prisms melting at 100.5° ; in a 2 per cent. solution in benzene at 18° , it has the specific rotation $[\alpha]_D = +228.8^\circ$ and the molecular rotation $[M]_D = +606.4^\circ$. Tetrahydroparatoluquinaldine is homologous with the tetrahydroquin-

aldine recently resolved by Pope and Peachey (*Proc.*, 1899, 15, 124), and the two bases exhibit interesting relationships. Thus dextro- α -bromocamphorsulphonic acid in both cases separates the lævo-base from the externally compensated mixture. Further, in 2 per cent. solutions in benzene, the lævo-bases have the same molecular rotation, viz., $[\text{M}]_{\text{D}} = -130.2^{\circ}$. Again, on benzoylating the lævorotatory bases, dextrorotatory benzoyl derivatives are obtained, and these have nearly the same molecular rotations in solution in benzene.

99. "Isomeric salts of hydrindamine containing pentavalent nitrogen."

By Frederic Stanley Kipping, D.Sc., F.R.S.

The base, α -hydrindamine, prepared by reducing the oxime of α -hydrindone (König, *Inaug. Diss. Leipzig*, 1889; Kipping and Revis, *Trans.*, 1897, 71, 238), combines with bromocamphorsulphonic acid yielding unequal quantities of two hydrated salts which can be separated by fractional crystallisation. After having been dried at 100° , the more sparingly soluble salt melts at about 150° , the more readily soluble one at about 130° ; both compounds have the composition $\text{C}_9\text{H}_{11}\text{N}, \text{C}_{10}\text{H}_{14}\text{BrO}\cdot\text{SO}_3\text{H}$.

Although α -hydrindamine contains an asymmetric carbon atom, and might, therefore, be expected to afford two salts under these conditions, the base regenerated from either of these salts by steam distillation with barium hydrate is optically inactive; the base thus regenerated also gives a hydrochloride and a benzoyl derivative identical in ordinary properties with the corresponding compounds prepared directly from the original externally compensated base. It appears, therefore, that fractional crystallisation of the salt formed with bromocamphorsulphonic acid does not effect a resolution of externally compensated hydrindamine, although this acid has been successfully employed by Pope and Peachey (*Proc.*, 1899, 15, 124) for the separation of the optically isomeric tetrahydroquinaldines.

When, moreover, the base regenerated from one of the isomeric salts is treated with bromocamphorsulphonic acid, it again yields a mixture of the two compounds; the salt of lower melting point is also transformed, partly or entirely, into the isomeride by evaporation with a solution of hydrindamine.

The difference between these two isomerides is not purely crystallographic, since both compounds retain their specific properties on repeated crystallisation from water and other solvents; they have also different specific rotations.

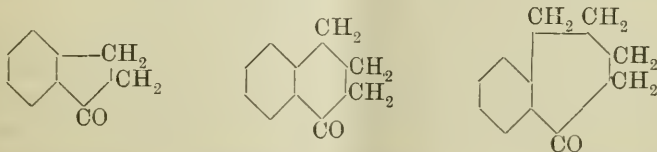
Two different salts, apparently analogous to those just described, are also obtained when hydrindamine is combined with chlorocamphorsulphonic acid, but these two compounds have not yet been studied.

Hydrindamine and levorotatory *cis*- π -camphanic acid (*Trans.*, 1896, 69, 943) also combine to form two isomeric anhydrous salts having the composition $C_9H_{11}N, C_{10}H_{14}O_4$; the two compounds can be separated by fractional crystallisation, and, although very similar in appearance, they differ in melting point by about 20° , the more sparingly soluble one melting at about 190° , the other at about 170° . The base regenerated from one of these salts appears to be inactive, and the isomerism of the two compounds seems to be of the same kind as that of the two salts of bromocamphorsulphonic acid. The more readily soluble *cis*- π -camphanate can be converted into the isomeride by evaporation with excess of a solution of hydrindamine; the specific rotations of the two salts are apparently different.

As it is impossible at present to arrive at any final conclusion as to the cause of the existence of the various isomeric salts briefly described in this note, only the more important facts have been recorded. It may be noted also that the assumption, that the isomerism is due to the pentavalent nitrogen atom being in a position in which its free rotation is prevented, explains some of the facts; another possible explanation is, that autoracemation of the free base occurs with great rapidity, but further experimental evidence is required before either view can be accepted.

100. "Synthesis of phenoketoheptamethylene." By F. Stanley Kipping, D.Sc., F.R.S., and Miss L. Hall.

In continuation of previous work on the formation of cycloid ketones (*Trans.*, 1894, 65, 480; 1899, 75, 144), the authors have studied the action of aluminium chloride on phenylvaleric chloride, $Ph \cdot CH_2 \cdot CH_2 \cdot CH_2 \cdot CH_2 \cdot COCl$, and find that, under suitable conditions, the reaction proceeds in accordance with the equation: $Ph \cdot [CH_2]_4 \cdot COCl = HCl + C_{11}H_{12}O$. The product is a ketone, and is in all probability a phenoketoheptamethylene (or phenoheptaphanone) produced by an intramolecular condensation exactly analogous to that which occurs in the formation of α -hydrindone and α -ketotetrahydronaphthalene from the chlorides of phenylpropionic acid and phenylbutyric acid respectively; the relationship between the three cycloid ketones which have now been prepared by this reaction is shown by the following formulæ:



α -Hydrindone. α -Ketotetrahydronaphthalene. Phenoketoheptamethylene.

Phenoketoheptamethylene is a colourless liquid having an odour very like that of peppermint; it is volatile in steam and only very sparingly soluble in water. *Phenoketoheptamethylene semicarbazone*, prepared in the usual manner, crystallises in glistening plates melting at about 219° ; it is decomposed by dilute sulphuric acid, the ketone being regenerated. The analysis of this compound gave $C=66.4$, $H=7.2$, the numbers demanded by theory for $C_{12}H_{15}N_3O$ being $C=66.4$, $H=6.9$ per cent. As the new ketone contains a closed chain of seven carbon atoms attached to the benzene nucleus, and is the first compound of this kind which has been obtained, the authors are making further experiments to confirm their views as to its constitution, and are also investigating its derivatives.

101. "Organic compounds containing silicon." By F. Stanley Kipping, D.Sc., F.R.S., and Lorenzo L. Lloyd.

Since the publication of various papers by Polis (*Ber.*, 1885, 18, 1542; 1886, 19, 1012, 1024), very little work has been done on organic compounds containing silicon, more especially as regards those of the aromatic series; the authors, having recently taken up the study of some compounds of this kind, desire to record briefly a few of their results. In the preparation of silicon tetraphenyl by the method described by Polis (*loc. cit.*), a bye-product melting at 148° is usually obtained in small quantities; this substance is triphenylsilicol ($(C_6H_5)_3Si \cdot OH$), and is doubtless identical with the compound obtained by Polis by decomposing triphenylsilicon chloride with water, in spite of the fact that the melting point assigned to it by Polis is only $139-141^{\circ}$. Triphenylsilicol crystallises in large, transparent prisms, and when boiled with acetic chloride it is converted into *triphenylsilicyl acetate*, $(C_6H_5)_3Si \cdot OAc$; the last-named compound forms colourless prisms and melts at $91-92^{\circ}$.

When triphenylsilicol is dissolved in glacial acetic acid and the solution warmed with a little concentrated nitric acid, a colourless, crystalline substance is gradually deposited; this product gave on analysis results agreeing with those required for *triphenylsilicyl ether*, $(C_6H_5)_3Si \cdot O \cdot Si(C_6H_5)_3$, and as it is also produced by the action of other mineral acids on the alcohol, there is little doubt as to its having this constitution. Triphenylsilicyl ether crystallises from acetic acid in colourless plates and melts at about 221° .

It has also been found that silicon tetrethyl (silicononane) (which was prepared long ago by Friedel and Crafts from silicon tetrachloride and zinc ethyl) can be obtained by treating a mixture of silicon tetrachloride and ethyl bromide with sodium; this method of preparation being a comparatively easy one, the investigation of silicon tetrethyl

and its derivatives is also being continued. The estimation of the silicon in many of those silicon compounds which volatilise without decomposition is best carried out by heating in a crucible with concentrated sulphuric acid and weighing the residual silica ; although this method may not be so generally applicable as that suggested by Polis (*Ber.*, 1886, 19, 1024), it gives very good results in many cases and is very easily carried out.

102. "The velocity of reaction before complete equilibrium." By Meyer Wilderman, B.Sc., Ph.D.

The reactions investigated were the solidification of supercooled liquids and solutions, the separation of the solid from the pure liquid solvent and from its solutions (*e.g.*, velocity of ice separating from pure water and from solutions of various salts), the separation of dissolved substance from supersaturated solutions, the melting of pure solid solvent in the warmer liquid solvent and in solutions, &c. The reactions take place very quickly, some of them lasting only 15 seconds. Advantage was taken of the fact that the above reactions were accompanied by an evolution or an absorption of heat, which is directly proportional to the amount of ice or salt separated. The velocity of ice separation was determined by the rate of change of temperature in the system. A platinum thermometer was used and the deflections of the galvanometer were photographed on a revolving drum. The author finds that the following general equation holds good for all the

above reactions, $\frac{dt}{dz} = C(t_0 - t)(t - t_{ov} + K)$, where t_0 is the temperature of equilibrium, t_{ov} that at which the reaction is started, K an instability constant. In other words, the velocity of reaction at the time z is directly proportional to the remoteness from the state of equilibrium, to the surface of contact of the two reacting parts of the heterogeneous system, and to the instability constant K . Hence a supercooled liquid or supersaturated solution must spontaneously crystallise when a certain limit, indicated by K , is passed. From the above equation, it follows that complete equilibrium is "static," whilst incomplete equilibrium is "dynamic."

103. "The ultraviolet absorption spectra of albuminoids in relation to that of tyrosin." By A. Wynter Blyth.

The author has studied the ultraviolet absorption spectra of egg-albumin, serum albumin, legumin, casein, Schrotter's albumose, certain toxalbumins, and tyrosin. He comes to the conclusion that the absorption band of ordinary albumin is identical with that of tyrosin. Gelatin, Schrotter's albumose, and certain other albuminoid

substances show no band; in these, tyrosin is absent. The author describes a special cell facilitating the study of absorption spectra. A solid block of quartz is cut into steps, the faces of the steps and the back of the quartz being highly polished; the cell is completed by a quartz plate and glass ends; in this way, with one filling, successive thicknesses may be brought before the slit.

104. "An explanation of the laws which govern substitution in the case of benzenoid compounds." (Third Notice.) By Henry E. Armstrong.

This subject was dealt with somewhat fully in two communications made to the Society in 1887 (*Trans.*, 51, 258, 583). It was then suggested that the formation mainly of meta-di-derivatives from mono-derivatives containing acidic radicles is perhaps due to the production, in the first instance, of a compound in which the acting molecule is associated with the acidic radicle. The object of the present note is to unreservedly withdraw this hypothesis, and to substitute what is believed to be a rational explanation, which has been arrived at after prolonged study of the subject with the assistance especially of Messrs. Berry and Lewis.

Owing to the readiness with which aniline is acted on by various agents, a false idea has been engendered as to the influence of nitrogen on substitution: in reality, it has a very slight predisposing power. Thus, although azobenzene readily forms an unstable perbromide, it is brominated only with difficulty, and is not easily acted on by substituting agents generally. Diazobenzene perbromide and the diazo-sulphonate from sulphanilic acid manifest complete indifference to bromine. In point of fact, there is little doubt that the activity of aniline and similar amines is the outcome of the presence of hydrogen in the amino-group; and it is even probable—as suggested in the second of these notices—that the formation of ortho- and para-compounds from primary and secondary amines is always preceded by that of the related compound in which hydrogen in the amino-group is displaced. A similar argument is applicable to the phenols, but there is little direct evidence of any prior displacement of the hydrogen of the hydroxyl group. In any case, in the formation of both ortho- and para-compounds from amines and phenols, there is reason to suppose that nitrogen and oxygen respectively act as attractive and also as orienting elements.

On the other hand, when meta-compounds are formed from amino-derivatives, probably it is because the nitrogen is so situated as to be both destitute of attracting power and possessed of ortho- and para-inhibiting power. Evidence of such inhibiting power is afforded by Miss Evans's observation (*Proc.*, 1895, 11, 235; 1896, 12, 234) that

when subjected to the action of bromine, dimethylanilineparasulphonic acid yields a mono-derivative which is stable in presence even of a large excess of bromine at ordinary temperatures—a behaviour altogether different from that of anilineparasulphonic acid, which is at once converted into tribromaniline on merely adding bromine to its aqueous solution.

When negative acid radicles are introduced into the amino-group of aniline, a far greater effect is produced than by positive radicles. Thus, when acetylsulphanilic acid is acted on by a single molecular proportion of bromine, at least 50 per cent. of parabromacetanilide is produced, and the monobrominated acid which is simultaneously formed yields practically nothing but dibromacetanilide when acted on by bromine. The behaviour of benzoysulphanilic acid is similar to that of the acetyl acid.

An equally remarkable effect is produced by alkylating phenolpara-sulphonic acid. Whereas this acid is converted with extreme facility into the dibromosulphonate and it is difficult to arrest the action at any earlier stage, the methoxy-, ethoxy- and benzyloxy-acids prepared from it yield a large proportion of the monobromophenol *ether* together with monobrominated sulphonate when subjected to the action of only a single molecular proportion of bromine, and when further acted on the monobrominated sulphonates yield dibromophenol ethers. But different radicles produce markedly different effects, the benzylated sulphonate giving little besides the bromo-ether, whereas the methylated and ethylated sulphonate yield about equal proportions of bromo-ether and bromo-sulphonate. The corresponding metacresol derivatives behave in a precisely similar way.

Ortho- and para-nitrophenetolsulphonates also directly exchange the sulphonic group for bromine, no trace of brominated acid being formed ; the corresponding phenol acids yield first a bromonitro-acid, and then the dibromonitrophenol.

But phenyl itself apparently exercises the greatest influence when it takes the places of the hydrogen in phenol, phenyl ether para-sulphonic acid, $\text{Ph} \cdot \text{O} \cdot \text{C}_6\text{H}_4 \cdot \text{SO}_3\text{H}$, absorbing but a small proportion of bromine, and without the sulphonic group being displaced.

The difference between an alkylated phenol and phenol is therefore similar to that which obtains between dialkylated aniline and aniline, and at least as great : the introduction of a complex radicle in place of aminic or hydroxylic hydrogen, in fact, produces effects which have not been as yet sufficiently considered.

In order to produce meta-derivatives from amines, it is necessary to paralyse as far as possible the ordinary ortho-para-orienting influence of the amino-group, and to give opportunity for the attack to take place in the nucleus ; abundant evidence has been obtained that this can be

done in many cases. When acetanilide is acted upon by sulphonating agents, it is initially converted into acetylsulphamic acid, *i.e.*, *sulphamated*; but the sulphamic acid is very prone to undergo change into sulphonic acid, and readily changes into ortho- or para-sulphonic acid, according to the conditions: consequently there is little opportunity for the sulphamic acid to sulphonate, and only traces of meta-acid can be obtained. Sulphamated benzanilide is far more stable, however, and it is easy under appropriate conditions to obtain a large proportion of benzoylmetanilic acid by sulphonating benzanilide; but the action readily proceeds a stage further, the benzoyl also becoming sulphonated. Paracetoluide and orthacetoluide, also readily yield acids in which the sulphonic group is meta- to the nitrogen when the conditions are so chosen as to sulphonate the sulphamate which is initially formed. Again, if parabromacetanilide be cautiously dissolved in strongly fuming acid, and the solution be poured on ice and the liquid boiled, a product rich in ortho-acid is obtained; but if the sulphonation be less carefully conducted, so as to give opportunity for all the sulphamate to sulphonate, pure meta-acid is eventually obtained. Both 2:4- and 2:6-dibromacetanilide give meta-acid with far greater facility, the sulphamate in these cases being very insensitive to change, so that the ortho-acid is obtained from the one and the para-acid from the other only by heating the sulphate of the amine at about 180°.

In the case of phenol, although when deprived of the company of hydrogen oxygen acquires marked inhibitory powers, being destitute of basic properties, it cannot be rendered sufficiently unattractive to prevent its exercising ortho- and para-orienting power, consequently phenolic compounds do not yield meta-derivatives. But it is very noteworthy that 2:6-dibromophenetol is converted into a polysulphonic acid with exceptional facility, just as dimethyl- and diethyl-aniline yield, the one a tetra-, the other a penta-derivative when brominated, although aniline yields only tribromaniline.

Briefly stated, the view now advocated is that in compounds which ordinarily furnish meta-di-derivatives, the radicle (NO_2 , CO_2H , &c.) is not only unattractive and possessed of little or no ortho-para-orienting power, but even exercises an inhibiting influence on these positions: consequently, when the two elements of any substituting agent become associated with positions 3 and 4 of the benzene nucleus, separation takes place from 4 rather than from 3, and therefore the meta-derivative is the chief product. The very numerous points of detail which require discussion will be dealt with in a paper in which the results alluded to in the course of this abstract and many others will be fully displayed.

105. "The colouring matters of dyer's broom and heather." By
A. G. Perkin and F. G. Newbury.

The *Genista tinctoria* (dyer's broom), a yellow dyestuff formerly of some importance, contains two colouring matters, the first identical with the luteolin of weld (*Reseda luteola*), and the second, a new colouring matter, *genistein*. The latter has a composition corresponding to the formula $C_{14}H_{10}O_5$, colourless needles, and yields an acetyl derivative, $C_{14}H_7O_5(C_2H_3O)_3$, m. p. 197—201°, and a tetrabromo-compound, $C_{14}H_6Br_4O_5$, colourless needles melting above 290°. On decomposition with alkali, it gives phloroglucinol and an acid of the formula $C_8H_5O_3$, m. p. 147—149°; this, with fused alkali, forms parahydroxybenzoic acid, and appears to be *parahydroxyphenylacetic acid*. *Genistein dimethylether*, colourless leaflets, m. p. 137—139°, is insoluble in alkaline solutions, but forms a *monacetyl derivative* of the formula $C_{14}H_7O_5(OCH_3)_2 \cdot Ac$, fine needles, m. p. 202—204°. A second product of the methylation, formed in minute quantity, melts at 187—189°, and appears to be isomeric with the above ether. In dyeing property, *genistein* closely resembles apigenin and vitexin, and to it the constitution of a *trihydroxyphenylketocumaran*, $(OH)_2 \cdot C_6H_2 \begin{smallmatrix} \diagup O \\ \diagdown CO \end{smallmatrix} CH \cdot C_6H_4(OH)$, has been provisionally assigned. The colouring matter of *Calluna vulgaris* (heather) is quercetin, and there is also present a catechol-tannin in small quantity.

ADDITIONS TO THE LIBRARY.

I. Donations.

Armstrong, Lord. Electric movement in air and water, with theoretical inferences. With a Supplement, a continuation of his experiments, together with an extension of them made in concert with Professor Henry Stroud. 2 vols. London. 1897—1899.

From the Author.

Tilden, W. A. A short history of the progress of Scientific Chemistry in our own times. London. 1899. From the Author.

Addison, W. I. A roll of the Graduates of the University of Glasgow, from December 31, 1727, to December 31, 1897, with short biographical notes. Glasgow. 1898. From the University.

Sloane, T. O'C. Liquid Air and the Liquefaction of Gases; theory, history, biography, practical applications, and manufacture. London. 1899. From the Publishers.

LIBRARY.

The Library will be closed during the last fortnight in August for cleaning and for the annual revision of the Catalogue. Fellows are requested to return all books in their possession not later than August 8th.

PROCEEDINGS
OF THE
CHEMICAL SOCIETY.
EDITED BY THE SECRETARIES.

Vol. 15.

No. 213.

The following are the abstracts of papers received during the vacation, and published in the *Transactions* :—

106. "Researches on the alkyl-substituted succinic acids. Part I. Methods of preparation." By William A. Bone and Charles H. G. Sprankling.

These acids may be prepared in quantity from the ethyl cyano-succinates produced by the interaction of ethyl cyanacetate and the esters of α -brom- fatty acids (*Proc.*, 1899, 15, 5).

An account is given of the properties of the ethyl methylecyano-succinates, the corresponding methylsuccinic acids, their characteristic anhydrides, anilic acids, and calcium salts.

107. "Some derivatives of dibenzyl ketone." By Francis E. Francis, B.Sc., Ph.D.

Following R. Schiff's work on the interaction of benzal-aniline and acetoacetic ester and similar ketones, three isomeric addition products were obtained when dibenzyl ketone was employed. The first is produced by the action of corresponding amounts of the ketone and benzal-aniline, the second when the reaction takes place in the presence of traces of piperidine, and the third by the action of a trace of sodium ethoxide on either of the addition compounds obtained in the preceding reactions. No colour reaction with ferric chloride is given by either the ketone or any of the three isomeric substances. Like dibenzyl ketone, desoxybenzoin when treated with benzal-aniline, gives three substances corresponding to the above, but, unlike it, it

gives a fourth with piperidine, which is much less soluble and possesses a much higher melting point than the others. The oxime and hydrazone, and the compounds formed by the action of ammonia and aniline on monobromodibenzyl ketone, are described.

108. "Action of light and of oxygen on dibenzyl ketone."

By Emily C. Fortey, B.Sc.

When dibenzyl ketone is exposed to air in presence of sunlight, partial decomposition takes place with formation of benzaldehyde, benzoic acid, and phenylacetic acid. After prolonged exposure of a sealed tube containing the ketone with oxygen, another reaction was found to have taken place, carbon monoxide and toluene being produced, together with a substance melting at $193-194^{\circ}$ and having a composition corresponding with the formula $C_{15}H_{13}O$. These products were also formed when dibenzyl ketone was exposed in vacuous tubes or tubes filled with carbon dioxide.

109. "The vapour pressures, specific volumes, and critical constants of hexamethylene." By Sydney Young, D.Sc., F.R.S., and Emily C. Fortey, B.Sc.

A specimen of hexamethylene obtained by fractional distillation from Galician petroleum was found to solidify, though not completely in an ordinary freezing mixture. It was therefore still further purified by fractional crystallisation until the melting point rose to 4.7° . The density of the liquid at $0^{\circ}/4^{\circ}$ was 0.79675, b. p. 80.9° , at 760 mm. The vapour pressures, specific volumes, and critical constants were determined; the latter are: critical temperature = 280.0° , critical pressure = 30252 mm., critical volume of a gram = 3.659.

110. "The composition and tensions of dissociation of the ammoniacal chlorides of cadmium." By Wm. R. Lang, D.Sc., and Albert Rigaut.

This paper gives the results of experiments on the compounds formed by cadmium chloride with ammonia. The compound formed by the action of liquid ammonia at a temperature of -70° has the formula, $CdCl_2 \cdot 6NH_3$. This substance, heated to 100° , loses ammonia becoming $CdCl_2 \cdot 2NH_3$, which is extremely stable like the corresponding salt of zinc, and begins to decompose at 210° , whilst at 360° decomposition is still incomplete. By the action of a solution of ammonia, the diammoniacal compound is always obtained; if the hexammoniacal and those intermediate are required, gaseous ammonia

must be passed into the solution. The tensions of these compounds, at temperatures varying from 0° to 70° , were measured; they show that at 60° the hexammoniacal compound ceases to exist and, consequently, for the possible penta-, tetra-, and tri-ammoniacal compounds, temperatures between 60° and 100° must be employed.

111. "The aluminium-mercury couple. I. Action of sulphur chloride on some hydrocarbons in presence of the couple." By Julius B. Cohen and Frederick W. Skirrow.

It has been shown by Hirst and Cohen (*Trans.*, 1895, 67, 826) that the action of the aluminium-mercury couple closely resembles that of aluminium chloride (Friedel and Crafts, *Ann. Chim. Phys.*, 1884, [vi], 1, 520). The authors find that the couple is capable of wide application both as a condensing agent and as a halogen carrier. Sulphur chloride (S_2Cl_2) acts vigorously on the aromatic hydrocarbons in presence of the couple forming the disulphides. *Diphenylene disulphide*, $C_6H_4:S_2:C_6H_4$, and *ditolylene disulphide*, $C_7H_6:S_2:C_7H_6$, were prepared in this way.

Dixylene disulphide yields, on distillation, xylyl hydrosulphide, a liquid with a low boiling point. The corresponding cumene compound forms a crystalline sulphhydrate, $C_9H_{11}SH$, m. p. $87-90^{\circ}$. A compound probably identical with this is obtained from pseudocumylene disulphide together with the sulphide $(C_9H_{11})_2S$, m. p. $110-111^{\circ}$. The products obtained by the distillation of dicymylene disulphide are liquid and consist of a mixture of the sulphide and hydrosulphide. Sulphur chloride also acts on heptane in presence of the couple; but the product could not be crystallised.

112. "The aluminium-mercury couple. II. The action of bromine on organic compounds in presence of the couple." By Julius B. Cohen and Henry D. Dakin.

The aluminium-mercury couple may be used as a bromine carrier. In presence of small quantities of the couple, bromine forms substitution products with the aromatic hydrocarbons and with the paraffins, very satisfactory yields being obtained. The following substances were prepared in this way: bromobenzene, C_6H_5Br ; bromotoluene, C_6H_4MeBr ; bromo-*m*-xylene, $C_6H_3Me_2Br$; chlorobromobenzene, C_6H_4ClBr , from chlorobenzene; bromo-*p*-chlorotoluene, $C_6H_3MeClBr$, from *p*-chlorotoluene; *p*-dibromobenzene, $C_6H_4Br_2$, from bromobenzene; 1:2:4:5-tetrabromobenzene, $C_6H_2Br_4$, and hexabromobenzene, C_6Br_6 , from dibromobenzene, and dibromochlorotoluene,

$C_6H_5MeClBr_2$, from bromo-*p*-chlorotoluene. Heptyl bromide, tetrabromoheptane, $C_7H_{12}Br_4$, and a third product, isomeric or polymeric with the latter, were obtained from heptane.

113. "Experiments on the constitution of isocamphoronic acid." By W. H. Perkin, jun., and Jocelyn Field Thorpe.

During the course of experiments on the synthesis of isocamphoronic acid, the authors have prepared a substance of the constitution $CO_2H \cdot CH_2 \cdot CMe_2 \cdot CH(CO_2H) \cdot CH_2 \cdot CO_2H$, which Baeyer suggested as probably representing this acid, but they find that their synthetical acid is not identical with isocamphoronic acid.

When the sodium derivative of ethyl cyanodimethylglutarate, $CO_2Et \cdot C(CN)Na \cdot CMe_2 \cdot CH_2 \cdot CO_2Et$ (compare *Trans.*, 1899, 75, 63), is digested with ethyl bromacetate, *ethyl cyanodimethylbutanetricarboxylate*, $CO_2Et \cdot C(CN) \cdot CMe_2 \cdot \underset{\substack{| \\ CH_2 \cdot CO_2Et}}{CH_2} \cdot CO_2Et$, is obtained as a colourless oil which

boils at 223—227° under 25 mm. pressure. This ethereal salt, on hydrolysis with sulphuric acid, yields the *dimethylbutanetricarboxylic acid*, $CO_2H \cdot CH_2 \cdot CMe_2 \cdot CH(CO_2H) \cdot CH_2 \cdot CO_2H$, represented above.

This acid has the very remarkable property of being apparently incapable of crystallising, as even when prepared by the hydrolysis of its pure ethyl salt—a colourless oil boiling quite constantly at 182—183° (22 mm.)—or when set free from its characteristic calcium salt, it is always obtained as a thick, colourless syrup. It thus differs widely from isocamphoronic acid, which crystallises with great facility.

When dimethylbutanetricarboxylic acid is distilled, it is converted into the corresponding *anhydro acid*, $\underset{\substack{| \\ CO \cdot O \cdot CO}}{CH_2 - CH} \cdot CMe_2 \cdot \underset{\substack{| \\ CO_2H}}{CH_2}$, a colourless oil which distils at 240—242° under 16 mm. pressure.

114. "The *cis*- and *trans*- β -phenylbutane- $\alpha\alpha_1\alpha_2$ -tricarboxylic acids." By Jocelyn Field Thorpe and William Udall.

These acids, which are constituted somewhat analogously to the dimethylbutanetricarboxylic acid described in the preceding abstract, may be prepared as follows.

In the first place, ethyl cinnamate is digested with the sodium derivative of ethyl cyanacetate, when combination takes place readily with the formation of the sodium derivative of *ethyl phenylecyanoglutarate*, $CO_2Et \cdot CH_2 \cdot CHPh \cdot CNa(CN) \cdot CO_2Et$. This compound reacts readily with ethyl bromacetate, yielding *ethyl phenylecyanobutanetricarboxylate*, $CO_2Et \cdot CH_2 \cdot CHPh \cdot C(CN)(CO_2Et) \cdot CH_2 \cdot CO_2Et$. This ethereal salt, which is a thick oil boiling at 270—280° (20 mm.),

is converted on hydrolysis into a mixture of the *cis*- and *trans*-*phenylbutanetricarboxylic acids*, $\text{CO}_2\text{H} \cdot \text{CH}_2 \cdot \text{CHPh} \cdot \text{CH}(\text{CO}_2\text{H}) \cdot \text{CH}_2 \cdot \text{CO}_2\text{H}$. The *trans*-acid crystallises from water in prisms containing $\frac{1}{2}\text{H}_2\text{O}$, but in the anhydrous condition it is a gum, with properties somewhat similar to those of the dimethylbutanetricarboxylic acid above described. The *cis*-acid melts at $178\text{--}180^\circ$, and is much more soluble in water than the *trans*-acid.

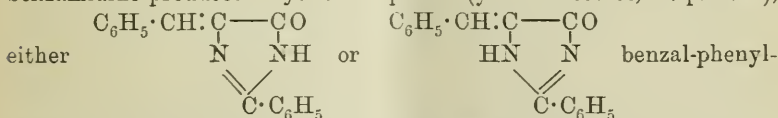
When treated with acetyl chloride, both acids yield the same anhydro-acid of the probable constitution $\begin{array}{c} \text{CO} \cdot \text{CH}_2 \\ | \quad \diagup \\ \text{O} \text{---} \text{CO} \end{array} > \text{CH} \cdot \text{CHPh} \cdot \text{CH}_2 \cdot \text{CO}_2\text{H}$, which melts at $134\text{--}135^\circ$.

115. "Further studies on the acids of the acetylene series." By Siegfried Ruhemann and Alfred V. Cunningham.

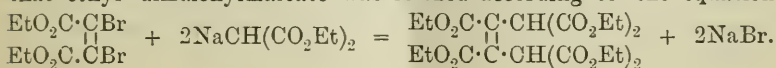
Ruhemann and Browning (*Trans.*, 1898, 73, 723) have shown that the ethyl salts of unsaturated acids combine with piperidine, and that, in the case of ethyl phenylpropiolate, union takes place with great evolution of heat. Diethylamine does not combine with the salt until the mixture is heated to 100° , though like piperidine, it combines with ethyl acetylenedicarboxylate very readily at ordinary temperatures. The compounds thus formed have the

general formulæ $\begin{array}{c} \text{R} \cdot \text{C} : \text{CH} \cdot \text{CO}_2\text{Et} \\ | \\ \text{N} \text{C}_5\text{H}_{10} \end{array}$ and $\begin{array}{c} \text{R} \cdot \text{C} : \text{CH} \cdot \text{CO}_2\text{Et} \\ | \\ \text{N}(\text{Et})_2 \end{array}$. The authors

further show that whilst urea and hydroxylamine react with ethyl phenylpropiolate, forming the ureide, $\text{C}_6\text{H}_5 \cdot \text{C} : \text{C} \cdot \text{CONHCONH}_2$ (pale yellow needles, m. p. 220°), and the hydroxamic acid, $\text{C}_6\text{H}_5 \cdot \text{C} : \text{C} \cdot \text{C}(\text{NOH})\text{OH}$ (colourless needles, m. p. $168\text{--}169^\circ$) respectively, benzamidine produces a cyclic compound (yellow needles, m. p. 274°),



glyoxalidone. They have also studied the additive products obtained by the action of bromine on ethyl phenylpropiolate and ethyl acetylenedicarboxylate (*i.e.*, ethyl dibromocinnamate and ethyl dibromomaleate respectively), and point out the remarkable difference in their stability. Ethyl sodiomalonate does not react with ethyl dibromocinnamate, but it does with ethyl dibromomaleate. This action, however, does not occur in the manner stated by G. Pum (*Monats.*, 1888, 9, 446), who supposed that ethyl dimalonylmaleate was formed according to the equation



The authors prove that this substance is nothing but ethyl ethanetetra-carboxylate, which is produced thus:



The ethyl acetylenedicarboxylate appearing in the equation unites with the ethyl malonate present and forms ethyl propenetetra-

carboxylate, $\begin{array}{c} \text{CH}(\text{CO}_2\text{Et}) \\ | \\ \text{CCO}_2\text{Et} \\ | \\ \text{CH}(\text{CO}_2\text{Et})_2 \end{array}$. This result shows that the substances

obtained by Pum from his so-called ethyl dimalonylmaleate are the well-known products of the transformation of ethyl ethanetetra-carboxylate. His dimalonylmaleic acid is ethenyltricarboxylic acid, and his diglycolylmaleic acid appears, therefore, to be succinic acid.

116. "A contribution to the chemistry of the mandelic acids." By Alex. McKenzie, M.A., D.Sc.

The work was undertaken in order to obtain *d*- and *l*-mandelic acids for the preparation of the optically active phenylalkyloxyacetic acids recently described by the author (*Trans.*, 1899, 75, 753). Although recourse was eventually had to amygdalin as a convenient source of *l*-mandelic acid, the results with mandelic acid are given in view of the attention at present directed to the general subject.

Inactive mandelic acid was resolved on the large scale by use of quinidine and cinchonine. From the pure *d*- and *l*-acids so obtained, the salts of cinchonine, cinchonidine, quinine, quinidine, strychnine, brucine, and morphine were prepared, solubility determinations of which showed that the acid can be conveniently resolved into its optically active components by quinine, or, better, by morphine in alcoholic solution.

A number of metallic salts of the mandelic acids were prepared with the view of ascertaining whether any of them would lend themselves to separation by crystallisation. The attempts to obtain the separation of one enantiomorph by spontaneous crystallisation were unsuccessful, owing, the author supposes, to the "transition temperature" not having been reached, or to hemihedrism being absent or masked in the crystals of the active isomers.

117. "Non-existence of the so-called 'suboxide of phosphorus.'" By David Leonard Chapman and F. Austin Lidbury.

The authors have examined specimens of the supposed suboxide, prepared by the methods of Goldschmidt and Reinitzer, and of Michaelis and Pitsch, and have compared their physical and chemical

properties with those of red phosphorus in a finely divided state, prepared by the action of sunlight on a strong solution of phosphorus in carbon disulphide. They find complete coincidence of properties in both cases; and it is pointed out that no physical or chemical property has yet been observed by which these substances may be distinguished from one another. Analyses show that when purified as completely as possible, the percentage of phosphorus is greater in all cases than the formula P_4O demands; the impurities in the phosphorus being due chiefly to the presence of acids of phosphorus formed by the action of water during preparation.

They conclude that the so-called suboxide is only an impure form of red phosphorus.

118. "The chlorine derivatives of pyridine. Part III. The interaction of chlorine and pyridine hydrochloride." By W. J. Sell, M.A., F.I.C., and F. W. Dootson, M.A.

The authors have previously described a method of obtaining a considerable number of the chloropyridines (*Trans.*, 1898, **63**, 432). With a view to simplifying the method and increasing the yield, they have examined the action of chlorine on pyridine hydrochloride, and succeeded in obtaining (1) a dichloropyridine not hitherto obtained by them, (2) a tetrachloropyridine, in large quantity, melting at 21–22°, (3) pentachloropyridine, (4) an aminotrichloropyridine, and (5) a compound of the empirical formula $C_{10}Cl_{11}HN_2$ and certain of its derivatives.

The substance (5), which is formed in considerable quantity, is regarded as being derived from two pyridine nuclei, and is still under examination.

119. "Amidoamidines of the naphthalene series." By Raphael Meldola and Percy P. Phillips.

The authors have continued the investigation of the ethenyltriamido-naphthalene described in 1887 (Meldola and F. W. Streatfeild, *Trans.*, **51**, 691). The acetyl and benzoyl derivatives are described, and the acid character of the NH -group of the amidine ring is made known by the formation of a silver compound and the corresponding N -methyl derivative. The diazotisable character of the NH_2 -group has been further studied, and it is shown that the amidoamine is also capable of combining with diazonium salts of other bases. The products do not appear to be simply diazoamido- or amido-azo-compounds as might have been expected from their mode of formation. The investigation of the latter is being continued.

November 2nd, 1899. Dr. W. H. Perkin, F.R.S., Vice-President, in the Chair.

Messrs. F. J. Beale, George Young, H. Royal-Dawson, E. T. Shelbourn, S. J. Peachey, H. A. Thiersch, R. W. Lindsay, S. Dickson, F. N. A. Fleischmann, and C. Simmonds were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. James William Anderson, 1, Preston Villas, Halling, Kent; Francis Paul Armitage, High House, Brook Green, Hammersmith, W.; Frederick William Armstrong, The Hill, Langport, Somerset; Frederic Arnold Beesley, Bank House, Wirksworth, Derby; Edgar Marsh Chapman, 17, Bloomsbury Square, W.C.; John Arthur Dewhirst, 125, Mount View Road, Stroud Green, N.; Frank Rawlinson Dudderidge, 45, Sidney Grove, Newcastle-on-Tyne; Herbert Frederick Francis Burdett Fermor, 15, Ansdell Road, Peckham, S.E.; Elliott Henry Gurney, Albert Street, Marrickville, New South Wales; Henry Wulff Kinnersley, 4, The Avenue, Keynsham, Somerset; William Thomas Leeming, 60, Lomeshaye Road, Nelson; Stephen Joshua Lett, 25, Percy Street, Liverpool; Edward Watkin Lewis, 64, Ommaney Road, New Cross, S.E.; Wm. D. McCreath, The Plains, Totnes, S. Devon; Harry Ainley Neale, Brentwood, Clothorn Road, Didsbury, Manchester; Thomas Henry Palmer, "Amalfi," Longueville, Sydney, New South Wales; Marchant Pearson, The Grammar School, Bridlington; Bennett C. Polkinghorne, 46, Lynette Avenue, Clapham Common, S.W.; Georges Ponthieu, Pharmacie Centrale de France, Avenue de Paris, St. Denis, Seine; William Downing Raynor, 13, Christ Church Road, Doncaster; Christopher Foulis Roundell, Guards' Club, Pall Mall, S.W.; William Russell, Thetford, Norfolk; Robert Hawks Walton, 424, Park Road, Moore Park, Sydney, N.S.W.; F. R. Leyland Wilson, Charterhouse, Godalming; John Wilson, 73, Melford Road, Leytonstone, E.

The chairman referred to the great loss the Society had sustained through the deaths of its illustrious former President, Sir Edward Frankland, and its Foreign Member, Professor Bunsen.

Of the following papers, those marked * were read:—

- *120. "On methods for determining the relative proportions of gaseous chloroform and air in a mixture of the two, and on a method for producing a mixture of air and chloroform in any desired proportion." By A. Vernon Harcourt.

To produce anaesthesia, air is inhaled mixed with a small percentage of chloroform vapour. The proportion of chloroform most suitable

for this purpose has not been determined, probably for want of a good chemical method of making this determination. The reaction which takes place between chloroform and a hot alcoholic solution of potash, $\text{CHCl}_3 + 4\text{KOH} = 3\text{KCl} + \text{HCO}_2\text{K} + 2\text{H}_2\text{O}$, seemed to furnish a basis for such a method. However, with regard to this reaction, two statements have been made, that all the chlorine of chloroform can thus be converted into a chloride and that it cannot. The author has worked out and described a method for removing chloroform vapour from air, and obtaining chloride from it by means of the above reaction; but on applying the method to weighed quantities of chloroform the results were always about 4 per cent. too low. This error is so nearly constant that the method may be used, and the results increased by 4 per cent.

A better method depending on a reaction (which, as far as the author knows, is new) has since been worked out by him.

When the mixture of air and chloroform is mixed with a certain proportion of steam by heating it with a few c.c. of water to 50° or 60° , and a platinum wire is kept in a state of incandescence in this mixture, the whole of the chloroform undergoes the following change: $2\text{CHCl}_3 + 2\text{H}_2\text{O} + \text{O}_2 = 6\text{HCl} + 2\text{CO}_2$. With a fairly bright wire the change is complete in an hour, and the hydrogen chloride may be obtained in dilute solution by bringing in 20 c.c. of water, and may be determined in the flask with a standard solution of ammonia. If enough steam is not present, or the platinum wire is not heated beyond a low incandescence, or sufficient time is not allowed, a smell of chlorine will be observed at the mouth of the flask and the result will be too low. It was ascertained incidentally that a weighed quantity of chlorine, treated as above, is completely converted into hydrogen chloride. Doubtless the changes $2\text{H}_2\text{O} + 2\text{Cl}_2 \rightleftharpoons 4\text{HCl} + \text{O}_2$ both occur, but the water present gradually withdraws all hydrogen chloride from the system.

The author also described a method of producing a mixture of air and chloroform in any desired proportion and of constant composition. This consisted in blowing air through a mixture of chloroform and alcohol. The density of the liquid, showing the proportion of its ingredients, could be observed during the passage of the air by means of two little glass bulbs, of which one floated and one sank when the density was right, and be adjusted by additions of chloroform. Density and temperature being constant, the proportion of chloroform taken up by the air was constant also. To remove alcohol vapour, the current of air was then passed through two wash-bottles containing sulphuric acid and water respectively.

DISCUSSION.

In reply to remarks by Mr. Hehner and Dr. Perkin, Mr. HARCOURT said he doubted whether the use of a Lux' balance for observing the density of the gas-stream would be as convenient as the Wolfe's bottle with two floats which he had used. The great difference in density of alcohol and chloroform made the density of the liquid in this case a good index of its composition. He thought a liquid less volatile than alcohol might be found and might have advantages; but alcohol answered well, was innocuous even if a little of its vapour passed on, and could easily be got pure.

***121. "The theory of saponification." By J. Lewkowitsch.**

The author showed that the view of the theory of saponification, according to which the hydrolysis of triglycerides is considered a tetramolecular reaction, must be abandoned in favour of the theory propounded by Geitel, who regards the reaction as bimolecular. If this be so, diglycerides and monoglycerides should occur in partially hydrolysed fats. The author has demonstrated their presence by acetylating the intermediate products, freed from glycerol, and proving that the acetylated products exhibit considerable acetyl values, which rise and fall with the progress of saponification. Additional proof was obtained by determining the amounts of the insoluble fatty acids of the acetylated products, and also their saponification values. The curves illustrating these two series of values correspond to the acetyl curves in a very satisfactory manner.

DISCUSSION.

Dr. LEWKOWITSCH said, in reply to questions from Mr. Blount and Mr. Hehner, that he had not tried any other methods beyond those mentioned, as, in his opinion, they were sufficient to give a satisfactory answer to the point at issue. The proportion of glycerine in the partially saponified samples might have been determined as a further proof, but the methods employed were shorter and more reliable. The saponification had been carried out in a manner corresponding to operations on a large scale, and since the steam pressure alone causes a very violent boiling and mixing of the mass, there could be little doubt that the samples taken did represent the average. He had not made use of water as a saponifying agent.

***122. "Note on the action of dilute nitric acid upon oleic and elaidic acids." By F. G. Edmed, B.Sc.**

In the course of some experiments on the oxidising action of nitric acid upon oleic acid, the author found that, by using nitric acid of

sp. gr. 1.2—1.3, the sole action was an isomeric change from oleic to elaidic acid. If the density of the acid did not exceed 1.25 and the action took place in the cold, the yield of elaidic acid was quantitative. Increase in the strength of the nitric acid and rise of temperature diminished the yield. The rapidity of the change was dependent on the purity of the oleic acid. The dilute nitric acid used in the experiments was carefully freed by prolonged boiling from nitrous acid, which is known to bring about a similar change.

Nitric acid of the strengths indicated above has no action in the cold upon elaidic acid itself. Hot concentrated nitric acid decomposes it only upon prolonged boiling.

DISCUSSION.

Mr. EDMED said in reply to Dr. LEWKOWITSCH that the specimen of elaidic acid thus prepared melted at 45° C.

*123. "Formation of tetrazoline." By S. Ruhemann and H. E. Stapleton.

On heating monoformylhydrazide at 210—220° for about 6 hours, the authors obtained a good yield of tetrazoline, $\text{CH} \begin{smallmatrix} \text{NH} \cdot \text{N} \\ \text{N} \cdot \text{NH} \end{smallmatrix} \text{CH}$. The hydrochloride of this base, $\text{C}_2\text{H}_4\text{N}_4\cdot\text{HCl}$, had been prepared recently by Pellizzari (*Atti R. Accad. dei Lincei*, 1899, [v], 8, I, 327) by heating diformylhydrazide and treating the crystalline product thus formed with hydrochloric acid. The authors find the melting point of this salt to be 151—152°. The free base is extremely soluble in alcohol and in chloroform, sparingly so in petroleum-ether. It crystallises from a mixture of chloroform and alcohol in colourless needles which melt at 82—83°, are very deliquescent, and give with copper sulphate a blue coloration. The picrate, $\text{C}_2\text{H}_4\text{N}_4\cdot\text{C}_6\text{H}_2(\text{NO}_2)_3\text{OH}$, forms yellow prisms, soluble in alcohol only with great difficulty.

DISCUSSION.

Dr. GEORGE YOUNG said that the authors of this paper had discarded the name dihydrotetrazine in favour of tetrazoline, the term introduced by Pellizzari. This was to be regretted as tending to confusion in the nomenclature of the carbo-nitrogen cyclic compounds. Dihydropyrrole was known as pyrroline, dihydropyrazole as pyrazoline. Tetrazoline should denote dihydrotetrazole, and not dihydrotetrazine. The name isotetrazoline was in use for certain dihydro-derivatives of tetrazole.

Mr. STAPLETON, in reply, said that although the alteration by

Pellizzari of the name dihydrotetrazine into tetrazoline was perhaps not altogether satisfactory, it had been accepted both by Pinner and Bamberger, and accordingly the authors of the paper had not hesitated to employ the term.

***124. "Asymmetric optically active nitrogen compounds. Dextro- and lævo-benzylphenylallylmethylammonium iodides and bromides." By William Jackson Pope and Stanley John Peachey.**

On heating the α -benzylphenylallylmethylammonium iodide prepared by Wedekind (*Ber.*, 1899, 32, 517) with one molecular proportion of silver dextrocamphorsulphonate dissolved in acetone and ethyl acetate, filtering, and evaporating to dryness, a crystalline residue was obtained which by fractional crystallisation from solution in acetone and ethyl acetate, may be resolved into the less soluble constituent, *dextro- α -benzylphenylallylmethylammonium dextrocamphorsulphonate*, $N(C_7H_7)Ph(C_3H_5)MeC_{10}H_{15}OSO_3$, and the more soluble isomeric dextrocamphorsulphonate of the *lævo-base*; the former has the molecular rotation in aqueous solution $[M]_D = +208^\circ$ and the latter $[M]_D = -87^\circ$.

On adding potassium iodide or bromide to aqueous solutions of these salts, the corresponding iodide or bromide is precipitated, and may be purified by crystallisation from alcohol; the following salts were thus obtained. *Dextro- α -benzylphenylallylmethylammonium iodide*, $N(C_7H_7)Ph(C_3H_5)MeI$, $[\alpha]_D = +52.4^\circ$. *Dextro- α -benzylphenylallylmethylammonium bromide*, $N(C_7H_7)Ph(C_3H_5)MeBr$, $[\alpha]_D = +68.6$. *Lævo- α -benzylphenylallylmethylammonium iodide*, $[\alpha]_D = -51.4^\circ$. *Lævo- α -benzylphenylallylmethylammonium bromide* $[\alpha]_D = -67.3^\circ$.

The isolation of these compounds proves that dissolved substances may owe their optical activity to the asymmetry of nitrogen.

It is further shown that Wedekind's iodide is not a racemic compound, but merely an ordinary or pseudoracemic mixture of the dextro- and lævo-components.

DISCUSSION.

Dr. ARMSTRONG thought this communication was the most valuable contribution made to stereochemistry since the introduction of geometrical considerations by Le Bel and van't Hoff.

The discovery of a method of preparing asymmetric nitrogen compounds was not only of intrinsic importance, but afforded a means of investigating the problem which chemists had so long disputed as to the valency of nitrogen in ammonium compounds. It would perhaps be possible by varying the number of radicles to discriminate between

compounds containing pentad and "molecular" compounds containing triad nitrogen.

Dr. LEWKOWITSCH said he fully appreciated the difficulties attendant on work of this kind, as some time ago he had attempted to prepare silicon compounds possessing optical activity, but so far without success. He ventured to suggest that these experiments might now be resumed.

125. "Camphoroxime. Part III. Behaviour of camphoroxime towards potassium hypobromite." By M. O. Forster, Ph.D., D.Sc.

With the object of preparing brominated derivatives of camphoroxime, the author has studied the behaviour of this substance towards alkaline hypobromite.

The compound, $C_{10}H_{16}BrNO_2$, obtained by the action of a concentrated ice-cold solution of potassium hypobromite on camphoroxime, crystallises from alcohol in snow-white, fern-like aggregates, and melts at 220° to a colourless liquid which immediately decomposes; it gives Liebermann's reaction for nitroso-derivatives, and yields camphoroxime on reduction with zinc dust and acetic acid. A two per cent. solution in benzene gave $[\alpha]_D = -65.6^\circ$.

The compound, $C_{10}H_{14}BrNO$, produced when the foregoing substance is dissolved in concentrated sulphuric acid, crystallises from alcohol in lustrous, transparent prisms; it shrinks and darkens at about 210° , becoming completely charred at 220° . This derivative is optically inactive, and does not give Liebermann's reaction. Treatment with hot, concentrated hydrochloric acid converts it into an *isomeride*, which separates from alcohol in large, transparent, six-sided crystals, and melts to a colourless liquid at 240° ; this modification is likewise optically inactive, and does not give Liebermann's reaction; it yields a *benzoyl* derivative, which crystallises from alcohol in lustrous scales melting at $174-176^\circ$.

The *nitrile*, $C_9H_{13}N$, obtained when either of the compounds, $C_{10}H_{14}BrNO$, is heated with aqueous soda, forms a limpid, fragrant oil which boils at $198-199^\circ$ under 760 mm. pressure, and has sp. gr. 0.9038 at 24° ; it is oxidised by an ice-cold solution of potassium permanganate, and instantly decolorises a solution of bromine in chloroform.

The *amide*, $C_9H_{15}NO$, occurs as a bye-product in the preparation of the nitrile, and is formed when that substance is heated with alcoholic potash; it crystallises from light petroleum in white, highly lustrous needles melting at 90° . When this compound is heated with hydrochloric acid, isolaureonolamide and isolaureonolic acid are produced, and as campholytic acid is converted by mineral acids into isolaureonolic

acid, it appears probable that the new amide is the hitherto unknown amide of campholytic acid. Experiments are being conducted with the view of ascertaining if this is so.

126. "Optical influence of an unsaturated linkage on certain derivatives of bornylamine." By M. O. Forster.

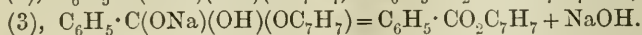
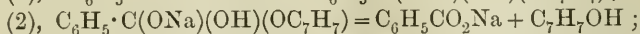
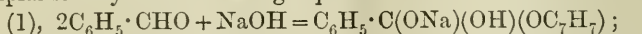
Condensation products of bornylamine with aromatic aldehydes have been prepared in order to compare the optical activity of such compounds with the corresponding derivatives of benzylbornylamine.

It is found that transition from benzylbornylamine and its nitro-derivatives to the corresponding benzylidene compounds is attended by a fall in the rotatory power of the benzene and alcoholic solutions; the decrease in the case of the paranitro-derivatives approximates to the rotational difference between benzylbornylamine and benzylidene-bornylamine, but is widely divergent from this in the case of the orthonitro-compounds.

Benzylidenebornylamine, o-nitrobenzylidenebornylamine, p-nitrobenzylidenebornylamine, o-hydroxybenzylidenebornylamine, and p-hydroxybenzylidenebornylamine are described in the paper.

127. "The interaction of sodium hydroxide and benzaldehyde." By Charles A. Kohn, B.Sc., Ph.D., and W. Trantom, B.Sc., Ph.D.

The object of the investigation was to ascertain if an intermediate compound was formed in the preparation of benzyl alcohol from benzaldehyde and soda. The authors state, that in presence of water, the sole products of the reaction are benzyl alcohol and sodium benzoate. By employing carefully dried materials, however, benzyl benzoate is formed to the extent of 10 per cent. The reactions which occur are explained by the following equations:—



Reaction (2) is favoured by the presence of water and excess of soda; reaction (3) by an excess of aldehyde.

128. "Electrolytic preparation of induline dyes." By E. C. Szarvasy, Ph.D.

When a mixture of aniline hydrochloride and aniline is fused and electrolysed under given conditions, induline colouring matters are formed. The author describes the apparatus he constructed to carry out these experiments. The following products were separated:

Induline, $C_{18}H_{13}N_3$; B4, anilidoinduline, $C_{24}H_{18}N_4$; induline 6B, $C_{30}H_{23}N_5$; and azophenine, $C_{36}H_{29}N_5$.

The results prove (1) that the chlorine produced by the electrolytic decomposition of the aniline hydrochloride effects diazotisation, (2) that under certain conditions the azo-compounds thus formed react with the hydrochloride of aniline, forming (3) primarily azophenine, (4) ultimately indulines.

129. "The heat of combination of copper with zinc." By T. J. Baker, B.Sc.

The only work in this direction hitherto appears to be by Dr. Galt (*Rep. Brit. Ass.*, 1898, and *Proc. Roy. Soc. Edin.*, 1899) and by Herschkowitsch (*Zeit. f. phys. Chem.*, 1898, 27, 123). Neither appeared until this work was nearly completed, and in each case the number of observations appears to have been small. In the present research, the method consisted in the determination of the difference between the heat of solution of an alloy of the two metals and that of an equal weight of a mixture in the same proportions. Actual determinations of the latter quantity were made, as it was not found possible to calculate it exactly from the heat of solution of the separate metals.

Two solvents were used. (a) Chlorine water (0.15 normal). (b) $HNO_3, 3H_2O$.

Only alloys with less than 42 per cent. copper could be so finely powdered as to dissolve quickly in chlorine water. With nitric acid as solvent, a series of 21 alloys (all made from the purest metals obtainable and carefully analysed) was examined. The results obtained by both methods agree very well.

The results are expressed in the form of a curve with percentages of copper as abscissæ and heats of formation of 1 gram of alloy as ordinates. From 0 to 30 per cent. of copper, no heat of combination could be detected. This renders doubtful the existence of the supposed compound, $CuZn_2$ (Laurie, Charpy, and Herschkowitsch).

From 30 to 62 per cent. of copper, the curve rises to an ill-defined maximum of 46 calories per gram of alloy. This alloy (62 per cent. copper) does not correspond to any simple atomic compound, but is otherwise remarkable (see 4th Report of the Alloys Research Committee Institution of Mechanical Engineers).

From 62 per cent. copper onwards, the curve gradually sinks to zero at 100 per cent. copper.

Hence copper and zinc evolve heat when alloying with one another, a point of interest with reference to the electro-deposition of brass.

The bearing of these experiments on Lord Kelvin's estimate of the limits of molecular dimensions is briefly discussed.

130. "The action of sulphuric acid on fenchone." By J. E. Marsh.

The author shows that by the action of strong sulphuric acid on fenchone, aceto-xylene (Me : Me : Ac = 1 : 2 : 4) was produced in quantity approximating to the total amount required by theory, and considers this fact to be opposed to the constitution of fenchone recently put forward by Wallach and by Gardner and Cockburn.

131. "On glucosides." By Hugh Ryan, M.A.

By the action of acetochloroglucose on solutions of phenols in alcoholic potash, crystalline glucosides of the β series were obtained.

$\beta\beta$ -Naphthol-glucoside, $C_6H_{11}O_5 \cdot OC_{10}H_7$, prepared from acetochloroglucose and β -naphthol, crystallises in long needles [m. p. 184—186°], is easily soluble in alcohol and in hot water, difficultly soluble in acetone, and scarcely soluble in benzene, ligroin, cold water, or ether, is readily hydrolysed either by dilute acids or emulsin, reduces Fehling's solution only after hydrolysis, is stable towards dilute alkali in which it is insoluble, and has a disagreeable taste.

β -p-Cresol-glucoside, m. p. 175—177°, and β -o-cresol-glucoside, $C_6H_{11}O_5 \cdot OC_6H_4CH_3$, m. p. 163—165°, resemble one another as well as naphthol-glucoside, crystallising from water in needles which are scarcely soluble in ether, benzene, or ligroin, but are fairly soluble in alcohol and in water, do not reduce Fehling's solution, are readily hydrolysed and possess a bitter taste.

β -Carracrol-glucoside, m. p. 135°, crystallises from water in needles not readily soluble in ether or cold water, easily soluble in alcohol and in acetone, but scarcely soluble in benzene, chloroform, or ligroin. It does not reduce Fehling's solution, dissolves slowly in dilute alkali, and is hydrolysable by means of dilute acids or emulsin. Its formula is

either $C_6H_{11}O_5 \cdot OC_6H_3 \cdot C_3H_7 \cdot CH_3, \frac{1}{2}H_2O$, or $C_6H_{11}O_5 \cdot C_6H_2 \begin{matrix} \nearrow C_3H_7 \\ OH, \frac{1}{2}H_2O. \\ \searrow CH_3 \end{matrix}$

d-Pentacetyl-glucose (m. p. 110°) is obtained by the action of 20 mols. of acetyl chloride on 1 mol. dry glucose in an open vessel.

Acetochloro-galactose, a colourless semi-solid mass, was got by the action of acetyl chloride on galactose in a closed tube and has been converted into a galactoside of β -naphthol.

132. "Notes on polyazo-compounds." By Raphael Meldola and William Arthur Williams.

Paranitrobenzeneazophenol (Meldola, *Trans.*, 1885, 47, 658) melts at 213—216° if the temperature of the bath is raised rapidly.

The melting point formerly given (184°) is erroneous, and the error has been corrected in the latest edition of Beilstein (vol. 4, p. 1410). The compound has been further characterised by its benzoyl and acetyl derivatives: $p\text{-NO}_2\cdot\text{C}_6\text{H}_4\cdot\text{N}_2\cdot\text{C}_6\text{H}_4\cdot\text{O}\cdot\text{CO}\cdot\text{C}_6\text{H}_5$; slender, orange needles, m. p. 195° . $p\text{-NO}_2\cdot\text{C}_6\text{H}_4\cdot\text{N}_2\cdot\text{C}_6\text{H}_4\cdot\text{O}\cdot\text{CO}\cdot\text{CH}_3$; dull, orange needles, m. p. 147° . The corresponding amidobenzazophenol melts at 186° (181° in original description) and forms a difficultly soluble sulphate crystallising in silvery scales having the formula $(p\text{-NH}_2\cdot\text{C}_6\text{H}_4\cdot\text{N}_2\cdot\text{C}_6\text{H}_4\cdot\text{OH})_2\cdot\text{H}_2\text{SO}_4 + 3\text{H}_2\text{O}$.

The base, on acetylation with acetic anhydride and sodium acetate, gives a mixture of a diacetyl with a monacetyl derivative, the latter being phenolic in character: $\text{C}_2\text{H}_3\text{O}\cdot\text{NH}\cdot\text{C}_6\text{H}_4\cdot\text{N}_2\cdot\text{C}_6\text{H}_4\cdot\text{OH}$; minute, dull orange needles, m. p. 203° ; $\text{C}_2\text{H}_3\text{O}\cdot\text{NH}\cdot\text{C}_6\text{H}_4\cdot\text{N}_2\cdot\text{C}_6\text{H}_4\cdot\text{O}\cdot\text{C}_2\text{H}_3\text{O}$; bright, orange scales, m. p. $236\text{--}237^{\circ}$.

The disazo-compound, $\text{C}_6\text{H}_4(\text{N}_2\cdot\text{C}_6\text{H}_4\cdot\text{OH})_2$ (Meldola, *loc. cit.*, 659), does not appear to be crystallisable. Boiling with acetic anhydride and dry sodium acetate results in the formation of the diacetyl derivative, $\text{C}_6\text{H}_4(\text{N}_2\cdot\text{C}_6\text{H}_4\cdot\text{O}\cdot\text{C}_2\text{H}_3\text{O})_2$, which crystallises from nitrobenzene in small, golden-yellow plates melting at $246\text{--}248^{\circ}$.

The amidobenzazophenol (m. p. 168°) obtained by Wallach and Schulze (*Ber.*, 1882, 15, 3021) by removing the acetyl group from the corresponding acetamido-compound, is the meta-compound isomeric with our para-compound (m. p. 186°).

Para-amidobenzazophenol, when treated at a low temperature with a mixture of dilute sulphuric acid and sodium dichromate, undergoes fission in a remarkable way. The azo-group remains attached to the $\text{NH}_2\cdot\text{C}_6\text{H}_4\text{--}$ residue with the formation of a diazodichromate of the complex $\text{NH}_2\cdot\text{C}_6\text{H}_4\cdot\text{N}_2\text{--}$ and the simultaneous oxidation of the $\text{C}_6\text{H}_4\cdot\text{OH}$ residue to quinone. This mode of decomposition of azo-compounds is being further investigated.

133. "On ethyl dibromobutanetetracarboxylate and the synthesis of tetrahydrofurfuran- $\alpha\alpha'$ -dicarboxylic acid." By Bevan Lean, D.Sc., B.A.

A solution of ethyl butanetetracarboxylate in chloroform is readily acted on by bromine with the formation of *ethyl $\alpha\alpha'$ -dibromobutanetetracarboxylate*, $\begin{array}{c} \text{CH}_2\cdot\text{CBr}(\text{CO}_2\text{Et})_2 \\ | \\ \text{CH}_2\cdot\text{CBr}(\text{CO}_2\text{Et})_2 \end{array}$.

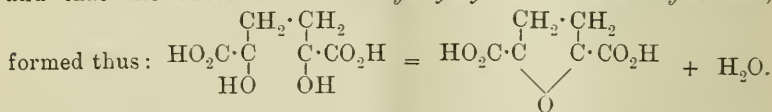
The crystalline dibromo-compound (m. p. 83°) thus obtained, when digested for some hours with a strong solution of barium hydroxide, yields an insoluble barium salt of dihydroxybutanetetracarboxylic acid, $\text{Ba}(\text{O}_2\text{C})_2\text{C}(\text{OH})\cdot\text{CH}_2\cdot\text{CH}_2\cdot\text{C}(\text{OH})(\text{CO}_2)_2\text{Ba}, \text{H}_2\text{O}$. If this salt is decomposed by sulphuric acid, there results a solution of *dihydroxy-*

butanetetra-carboxylic acid, $(\text{HO}_2\text{C})_2\text{C}(\text{OH})\cdot\text{CH}_2\cdot\text{CH}_2\cdot\text{C}(\text{OH})(\text{CO}_2\text{H})_2$. On slowly concentrating the very acid aqueous solution of this substance over strong sulphuric acid, long needles were obtained of the monolactone, $(\text{HO}_2\text{C})_2\text{C}\begin{array}{c} \text{O} \\ | \end{array}\cdot\text{CH}_2\cdot\text{CH}_2\cdot\text{C}\begin{array}{c} \text{O} \\ | \end{array}(\text{OH})\cdot\text{CO}_2\text{H}$. The silver salt of

this substance ($\text{C}_8\text{H}_8\text{O}_9$) was prepared and has the composition $\text{C}_8\text{H}_6\text{Ag}_4\text{O}_{10}$. The substance, therefore, readily takes up again the elements of water, as is customary with δ -lactones. It begins to soften at 145° , and at 156° fusion is complete and carbon dioxide is evolved.

On heating an aqueous solution of this lactone in a sealed tube at 150° , the acid is decomposed with elimination of carbon dioxide. If the aqueous solution be evaporated to a small bulk and placed over sulphuric acid, small, star-shaped clusters of crystals gradually appear, and eventually the whole becomes solid. The product is found to have the composition $\text{C}_6\text{H}_8\text{O}_5$, which is that of dihydroxyadipic acid less one molecule of water, and the simplest explanation would be that the substance is the δ -lactone of dihydroxyadipic acid, viz., $\text{CO}_2\text{H}\cdot\text{CH}\begin{array}{c} \text{O} \\ | \end{array}\cdot\text{CH}_2\cdot\text{CH}_2\cdot\text{CH}\begin{array}{c} \text{O} \\ | \end{array}(\text{OH})\cdot\text{CO}$. But careful examination shows that

this is not so, for the silver salt was prepared and found to have the composition $\text{C}_6\text{H}_6\text{Ag}_2\text{O}_5$. Further investigation shows that the elimination of water takes place between the two hydroxyl-groups, and that the substance is *tetrahydrofurfuran-aa'-dicarboxylic acid*,



This substance begins to melt at 65° , but fusion proceeds only gradually, and is not complete till about 120° . The absence of a definite melting point pointed to it being a mixture of stereoisomeric acids, and experiments were made to separate them by fractional crystallisation from water.

A higher melting *tetrahydrofurfuran-aa'-dicarboxylic acid* ($\text{C}_6\text{H}_8\text{O}_5$), m. p. $123\text{--}125^\circ$, was isolated, and also crystals melting at $63\text{--}64^\circ$, which had the composition $\text{C}_6\text{H}_{10}\text{O}_6$. This latter substance was at first supposed to be dihydroxyadipic acid, but the silver salt was prepared and found to be $\text{C}_6\text{H}_6\text{Ag}_2\text{O}_5$, a result which led to the conclusion that the substance was the isomeric *monohydrate of tetrahydrofurfurandicarboxylic acid*.

When the substance $\text{C}_6\text{H}_{10}\text{O}_6$ (m. p. $63\text{--}64^\circ$) was placed for some days over strong sulphuric acid, the product melted at $93\text{--}95^\circ$, and it then had the composition $\text{C}_6\text{H}_8\text{O}_5$. Its silver salt was $\text{C}_6\text{H}_6\text{Ag}_2\text{O}_5$, confirming the conclusion that the substance $\text{C}_6\text{H}_8\text{O}_5$ (m. p. $93\text{--}95^\circ$)

has the specific rotation $[\alpha]_D = +4.3^\circ$, whilst the latter gives $[\alpha]_D = +41.7^\circ$. Both salts are decomposed by water, yielding the corresponding optically active camphoroximes.

136. "The application of powerful optically active acids to the resolution of externally compensated basic substances. Resolution of tetrahydroparatoluquinaldine." By William Jackson Pope and Edmund Milton Rich.

In continuation of previous work (*Proc.*, 1899, 15, 171), the authors have isolated *dextrotetrahydroparatoluquinaldine* as its hydrochloride from the mother liquors remaining after separating the *lævo*-isomeride as dextrobromocamphorsulphonate from the externally compensated base; the *hydrochloride* of the new base crystallises in sphenoidally hemihedral orthorhombic crystals containing one molecule of water. The optically active bases themselves crystallise from light petroleum solutions in hemimorphic, monosymmetric prisms.

137. "Homogeneity of dextrolævo- α -phenethylamine dextrocamphorsulphonate." By William Jackson Pope and Alfred William Harvey.

Externally compensated α -phenethylamine combines with Reyhler's dextrocamphorsulphonic acid, yielding *dextrolævo- α -phenethylamine dextrocamphorsulphonate*, $\text{CH}_3 \cdot \text{CH}(\text{Ph}) \cdot \text{NH}_2 \cdot \text{C}_{10}\text{H}_{15}\text{OSO}_3\text{H}$, which crystallises from acetone in minute, colourless prisms melting at $141-143^\circ$. The salt has the molecular rotation $[\text{M}]_D = +51.5^\circ$ in dilute aqueous solution, and since ammonium dextrocamphorsulphonate gives $[\text{M}]_D = +51.7^\circ$ in aqueous solution, the new salt belongs to the class of partially racemic substances discovered by Ladenburg. Externally compensated *α -phenethylamine platinochloride*, $(\text{CH}_3 \cdot \text{CHPh} \cdot \text{NH}_2)_2 \cdot \text{H}_2\text{PtCl}_6$, crystallises in golden-yellow scales melting at $213-214^\circ$.

138. "The characterisation of racemic liquids." By Frederic Stanley Kipping and William Jackson Pope.

It is shown that the results obtained by Ladenburg's latest method (*Ber.*, 1899, 32, 1822) for discriminating between "racemic" and "non-racemic" liquids have no bearing upon the question they are supposed to answer.

Series of experiments have further been made to determine the equilibrium between mixtures of dextro- and *lævo*-pinene in various proportions and their solutions in ethyl and methyl alcohol. It is shown that the distribution ratio of the excess of one antipodes over

the other in the oil and in the alcoholic solution in contact with it is nearly independent of the concentration of that excess. This behaviour is explained by Nernst's distribution law, and would be expected with both racemic and non-racemic substances.

Experiments with dextro- and lævo-camphorsulphonic chlorides are also described, which show the fallacious nature of the conclusions drawn by the application of Ladenburg's method.

139. "A method for discriminating between 'non-racemic' and 'racemic' liquids." By William Jackson Pope and Stanley John Peachey.

The densities of lævo- and externally compensated tetrahydroquinaldine are the same under similar conditions, namely, $d_{t/4} = 1.01930 + 0.00079 (20 - t)$ between 14° and 21° ; their molecular refractions are also the same, the observed values being $M_D = 47.50$ for the active, and $M_D = 47.57$ for the inactive base. These numbers afford no evidence that the inactive liquid base is racemic.

The variations in specific rotation of non-electrolytes dissolved in various solvents are traced, in the main, to variations in the association factor of the dissolved substance, and it is shown that the highly associated lævotetrahydroquinaldine has specific rotations varying from $[\alpha]_D = -46^\circ$ to -118° in different solvents. On dissolving the base in solvents having nearly its own association factor, such as tetrahydroquinoline, the specific rotation of the active base remains nearly the same as in the solvent-free state, because its association factor remains nearly unchanged; lævotetrahydroquinaldine, when dissolved in the externally compensated base as solvent, has practically the same specific rotation as in the pure liquid state, namely, $[\alpha]_D = -58.12^\circ$. It follows that externally compensated tetrahydroquinaldine has the same molecular weight in the liquid state as its active components, and consequently cannot be a racemic compound.

It is shown that the specific rotation of lævopinene, an un-associated liquid, changes comparatively slightly with the solvent, and that it has the same specific rotation when dissolved in the externally compensated hydrocarbon as when in the pure liquid state. Inactive pinene is therefore not racemic.

The authors conclude that the above results afford the first method for discriminating between racemic and non-racemic liquids which has yielded positive results.

140. "On two hydrated cobalt oxides, green- and buff-coloured."

By W. N. Hartley, F.R.S.

The preparation and analysis of two hydrated cobalt oxides is described. The green compound was formed when a cold solution of cobalt chloride was precipitated by an equivalent quantity of barium hydroxide, both solutions having been boiled, and a Torricellian vacuum being maintained in the precipitating vessels. Its formula is $\text{Co}_3\text{O}_4, 6\text{H}_2\text{O}$. The buff-coloured compound resulted when the precipitation was carried out in like manner, but with excess of barium hydroxide. Its composition is $\text{Co}_8\text{O}_9, 11\text{H}_2\text{O}$.

The action of acetic acid on the green hydrate separates a brown oxide already known as Co_3O_4 . There was a similar action and the separation of black oxide from the buff-coloured hydrate. This points to the following formulæ: Green hydrate, $\text{Co}_2\text{O}_3, \text{Co}(\text{OH})_2, 5\text{H}_2\text{O}$. Buff hydrate, $\text{Co}_2\text{O}_3, 6\text{Co}(\text{OH})_2, 5\text{H}_2\text{O}$. These are distinct compounds, and not merely mixtures.

141. "A method of separating isomeric xylidenes from the commercial product." By W. R. Hodgkinson and L. Limpach.

This method depends on the fact that acetate of meta-(Me : Me : $\text{NH}_2 = 1 : 3 : 4$)-xylidine crystallises very readily when the crude mixture is treated with acetic acid. From the filtrate from this acetate, hydrogen chloride precipitates the para-(Me : NH_2 : Me = $1 : 2 : 4$)-xylidine as hydrochloride, and the filtrate from this, on concentration and heating, yields up the hydrochloride of the (Me : NH_2 : Me = $1 : 2 : 3$)-xylidine as a crystalline sublimate. The residue of hydrochlorides of the two ortho-(Me : Me : $\text{NH}_2 = 1 : 2 : 3$ and Me : Me : $\text{NH}_2 = 1 : 2 : 4$)-xylidenes is hydrolysed and the bases converted into formyl derivatives; that from the (Me : Me : $\text{NH}_2 = 1 : 2 : 3$)-base crystallises moderately easily, whilst the other from the (Me : Me : $\text{NH}_2 = 1 : 2 : 4$) base is exceedingly difficult to obtain as a solid.

142. "Action of hydrolytic agents on α -dibromocamphor, and the constitution of bromocamphorenic acid." By Arthur Lapworth.

In addition to the experiments already briefly described (*Proc.*, 1899, 15, 161), the paper gives an account of the behaviour of α -dibromocamphor towards hydrolytic agents other than moist silver compounds. It is found that this substance is readily attacked by mercurous nitrate dissolved in boiling acetic acid, and that a small quantity of bromocamphorenic acid is obtained. It is not attacked by lead compounds under these conditions, and chars when heated

with water and lead oxide in closed tubes to 120—150°; in the latter case, no bromocamphorenic acid could be detected, but a small quantity of camphoric acid, and in one instance a minute quantity of camphorquinone, was found to be produced.

The action of oxidising agents on dibromocampholid, bromocamphorenic acid, α -monobromocampholid and other derivatives of camphorenic acid has been investigated. It is found that in each case where oxidation occurs nearly pure homocamphorenic acid is obtained, an excellent yield of the latter substance being produced when α -monobromocampholid is oxidised with dilute nitric acid and silver nitrate.

ADDITIONS TO THE LIBRARY.

I. *By Donation.*

Halliburton, W. D. The essentials of chemical physiology, for the use of students. Third edition. London 1899.

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Parry, E. J. The chemistry of essential oils and artificial perfumes. Illustrated with engravings. London 1899.

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Guldberg, C. M., und Waage, P. Untersuchungen über die chemischen Affinitäten. Abhandlungen aus den Jahren 1864, 1867, 1879. Uebersetzt und herausgegeben von R. Abegg. ill. Leipzig 1899.

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Dymond, T. S. Report on the visit of Essex agriculturists to Holland, May and June, 1899. Chelmsford 1899.

Franklin, E. C., and Kraus, C. A. Determination of the molecular rise in the boiling point of liquid ammonia. (*American Chemical Journal*, vol. xx., 1898).

———. Liquid ammonia as a solvent. (*American Chemical Journal*, vol. xx., 1899.)

At the next meeting on Thursday, November 16th, the following papers will be read:—

“Chlorine derivatives of pyridine. Part IV. Constitution of the tetrachlorpyridines.” By W. J. Sell, M.A., and F. W. Dootson, M.A.

“Contributions to our knowledge of the aconite alkaloids. Part XV. On Japaconitine and the alkaloids of Japanese aconite.” By Wyndham R. Dunstan, F.R.S., and Harold M. Read.

“On the determination of transition temperatures.” By H. M. Dawson, Ph.D., B.Sc., and P. Williams, B.Sc.

PROCEEDINGS

OF THE

CHEMICAL SOCIETY.

EDITED BY THE SECRETARIES.

Vol. 15.

No. 214.

November 16th, 1899. Professor Thorpe, F.R.S., President, in the Chair.

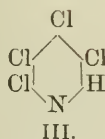
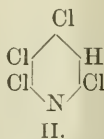
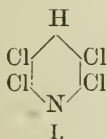
Certificates were read for the first time in favour of Messrs. Herbert William Hart, 13 Lynwood Villas, Darwen, Lancashire; Henry William Hutchin, Basset Road, Camborne.

The following Certificate was authorised by Council: Frank J. Pye, Towrang, New South Wales, Australia.

Of the following papers, those marked * were read.

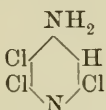
- *143. "The chlorine derivatives of pyridine. Part IV. The constitution of the tetrachloropyridines." By W. J. Sell, M.A., F.I.C., and F. W. Dootson, M.A.

The three theoretically possible tetrachloropyridines have all been obtained (*Trans.*, 1898, '73, 432), and are represented by the formulæ I, II, and III respectively.

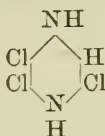
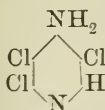


Having already proved (*Trans.*, 1897, 71, 1081) that the compound melting at 90—91° has the constitution represented by formula I, the authors show in the present paper that the isomer which melts at 21—22° is represented by formula III, and hence formula II must represent the constitution of the third isomer, which melts at 74—75°. Treatment with ammonia converts the compound melting

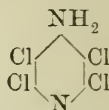
at 21—22° into an aminotrichloropyridine, which is quite different from that described by Stokes and Pechmann (*Amer. Chem. Jour.*, 1886, 6, 377), and shown by them to have either the formula IV or possibly IV_A; as the new compound contains an amino-group in the γ -position, it must be represented by formula V.



IV.

IV_A.

V.



VI.

That the γ -position is occupied by the amino-group is evident from the fact that when this new compound is heated with phosphorus pentachloride, the aminotetrachloropyridine obtained is that which has been shown by Stokes and Pechmann, and by the authors, to have the constitution represented by formula VI.

*144. "Contributions to our knowledge of the aconite alkaloids.

Part XV. On japaconitine and the alkaloids of Japanese aconite." By Wyndham R. Dunstan, F.R.S., and Harold M. Read.

The authors have investigated the properties of the alkaloids of Japanese aconite, *A. Fischeri* ("kuza uzu"), including those of japaconitine, the crystalline toxic alkaloid examined by Wright and Luff in 1879, who assigned to it the formula $C_{66}H_{88}N_2O_{21}$. Later workers, Mandelin, Lübke and, more recently, Freund and Beck, have asserted that japaconitine is identical with aconitine, the crystalline toxic alkaloid of *Aconitum Napellus*.

The results obtained in the present investigation do not confirm these statements, but lead to the conclusion that japaconitine is a distinct alkaloid, the composition and properties of which, however, do not agree with those ascribed to it by Wright and Luff.

Japaconitine crystallises in colourless needles which melt at 204.5° (corr.). The crystallographic characters differ from those of aconitine. The base is soluble in acetone, alcohol, chloroform, and in ether, but almost insoluble in water and light petroleum. Its physiological action closely resembles that of aconitine. It contains four methoxyl groups, one acetyl group, and one benzoyl group. Its composition is provisionally represented by the formula $C_{21}H_{29}(OCH_3)_4(CH_3CO)(C_6H_5CO)NO_3$, which seems to agree best with the analytical data for the base and its derivatives. *Japaconitine* furnishes a series of well crystallised salts, of which the *hydrochloride* (m. p. 149—150°), the *hydrobromide* (m. p. 172—173°), the *hydriodide* (m. p. 207—208°), the *aurichloride* (m. p. 231°), and the *nitrate* (m. p. 194°) are described. Like aconitine,

japaconitine is dextrorotatory, the salts being lævorotatory. The specific rotation of japaconitine is, however, much greater than that of aconitine.

When partially hydrolysed by dilute acids, japaconitine furnishes acetic acid, and a new crystalline base, *japbenzaconine*, in accordance with the equation $C_{34}H_{49}NO_{11} + H_2O = C_{32}H_{47}NO_{10} + C_2H_4O_2$. It crystallises in rectangular plates which melt at 182—183°. Its lævoration is nearly twice that of benzaconine. The salts crystallise with extreme readiness. The *hydrochloride* (m. p. 253°), the *hydrobromide* (m. p. 205°), the *aurichloride* (m. p. 228°), and the colourless *aurichlor-derivative* (m. p. 178°) are described.

Japbenzaconine is hydrolysed on treatment with acids or alkalis, yielding benzoic acid and a base, *japaconine*, in accordance with the equation $C_{32}H_{47}NO_{10} + H_2O = C_{25}H_{43}NO_9 + C_7H_6O_2$. Japaconine has been obtained only in an amorphous condition, even the salts crystallise with great difficulty. The *hydrobromide* melts at 221°.

When japaconitine melts, it gradually suffers decomposition into acetic acid, and a new crystalline base, *pyrojapaconitine*, $C_{32}H_{45}NO_9$. The crystalline *hydrochloride* (m. p. 175—176°), *hydrobromide* (m. p. 208°, or in another form at 241°), and *aurichloride* (m. p. 161°) are described. Both pyrojapaconitine and its salts are strongly lævorotatory.

Pyrojapaconitine is readily hydrolysed by alkalis or acids, yielding *benzoic acid* and *pyrojapaconine*, $C_{25}H_{41}NO_8$. Neither the base nor its salts have been crystallised.

Japaconitine yields a *triacetyl* derivative; and also a *monomethyl* derivative by decomposition of the *methiodide* with potash.

It is evident that the properties of japaconitine and its derivatives are distinct from those of aconitine and its derivatives, although there is a strong general resemblance between the two groups.

Besides the crystalline japaconitine, Japanese aconite roots were found to contain a small proportion of its first hydrolytic product, japbenzaconine.

DISCUSSION.

Professor TILDEN inquired how many aconitines were known possessing the physiological action of the original alkaloid from *Aconitum Napellus*, and pointed out the remarkable change in properties resulting from the elimination of the acetyl group from aconitine.

Mr. D. HOWARD said that it would be of extreme interest if any light could be thrown upon the relation of the chemical constitution of the aconite alkaloids to their physiological action, the problem being of the highest importance.

Professor DUNSTAN, in reply, stated that aconitine from *A. Napellus*, pseudoaconitine from *A. ferox*, and japaconitine from Japanese aconite (probably *A. Fischeri*) exerted a very similar physiological action. The relationship between the chemical constitution and the physiological action of these alkaloids and their derivatives was being investigated by Professor Cash and himself. They had already published (*Phil. Trans.*, 1898, 190, B, 239) an account of the work as far as it related to aconitine, benzaconine, and aconine, and had paid special attention to the almost entire loss of toxic power which results from the elimination of the acetyl group from aconitine. In fact, benzaconine and aconine, especially the latter, were found to be, in certain respects, physiologically antagonistic to aconitine.

***145. "The dissociation constants of very weak acids." By James Walker and William Cormack.**

A form of apparatus is described which enabled the authors to measure the electric conductivity of very weak acids with considerable accuracy, the method of experiment adopted being especially applicable to such acids as are gaseous under ordinary conditions.

The following table contains the chief results obtained, hydrochloric and acetic acids being added for purposes of comparison. The first column of figures gives the dissociation constants calculated by Ostwald's formula, the second column gives the percentage degrees of dissociation in decinormal solution, these numbers being proportional to the avidities of the acids.

	$K \times 10^{10}$	100 m.
Hydrochloric acid	—	91.4
Acetic acid	180,000	1.30
Carbonic acid	3,040	0.174
Hydrogen sulphide	570	0.075
Boric acid	17	0.013
Hydrocyanic acid	13	0.011
Phenol.....	1.3	0.0037

These results are in general harmony with the hydrolytic experiments of Shields.

DISCUSSION.

Mr. L. M. JONES asked whether the weak inorganic acids examined obeyed Ostwald's dilution law, as considerable differences occur with strong inorganic acids, and whether the dissociation in all cases proceeded with the formation of only the monovalent anion.

Mr. VERNON HARCOURT hoped that the actual measurements of the conductivity were given in the paper, and not only the inferences from

these measurements. Careful physical measurements, where all conditions were recorded, had a value more certain to endure than the theory used to interpret them.

Professor TILDEN mentioned that, at his suggestion, one of his students had lately studied the conductivity and hydrolytic effects of azoimide in the expectation of finding it a tolerably strong acid. The results of these experiments, which would shortly be communicated to the Society, however, led to the conclusion that azoimide is a weak acid standing very near to hydrocyanic acid.

Professor WALKER, in reply, said that all the acids investigated obeyed Ostwald's dilution law, and that the primary dissociation in each case was therefore into one atom of hydrogen and the rest of the molecule.

Whether the theory of electrolytic dissociation were finally accepted or rejected in its present form, the "degree of dissociation" would always remain a valuable and, indeed, indispensable magnitude where aqueous solutions of electrolytes were concerned, for by its means alone is it possible to calculate chemical equilibrium in such solutions. The interpretation and the name of the magnitude might be changed, but the magnitude itself is a fundamental one.

***146. "Preparation and properties of solid ammonium cyanate." By James Walker and John K. Wood.**

In a preliminary communication (*Proc.*, 1898, 108), the authors showed that pure solid ammonium cyanate might be prepared by mixing cooled ethereal solutions of ammonia and cyanic acid. The same substance can be produced by mixing ammonia gas and cyanic acid vapour at the ordinary temperature, provided the reacting gases are sufficiently diluted with some indifferent gas.

Measurements of the rate of transformation of the solid cyanate into urea showed that the rapidity of transformation increases very rapidly with rise of temperature, and that the presence of moisture greatly accelerates the action. About 3 per cent. of the cyanate is decomposed, with formation of ammonia.

The molecular heat of transformation of solid cyanate into solid urea is 49K; the molecular heat of formation of solid cyanate is 738K; and the molecular heat of solution in water is -62.3K. From these numbers, it appears that the molecular heat of transformation in aqueous solution is 75K.

Ethylammonium cyanate is rapidly transformed into ethyl-urea at the ordinary temperature. When ethereal solutions of aniline and cyanic acid are mixed, the substance which separates is not phenylammonium cyanate, but phenyl-urea.

*147. "Etherification of derivatives of β -naphthol." By William A. Davis.

The author has studied quantitatively the etherification of a considerable number of substitution derivatives of β -naphthol by means of alcohol and sulphuric acid. It is shown that a single group occupying position 1 has a most remarkable effect in limiting etherification, although the same group in position 3' exercises little influence.

The inhibiting influence of ortho-groups on the etherification of phenols, and of substituted benzoic acids, as studied by Victor Meyer and others, is fully discussed; the conclusion arrived at is that the stereochemical hypothesis proposed by V. Meyer to explain his results is not justified by facts.

The following ethers are described: 3'-bromo- β -methoxynaphthalene, m. p. 105°; 1-bromo- β -methoxynaphthalene, m. p. 82—83°; 1-chloro- β -methoxynaphthalene, m. p. 68°; 1:3'-dibromo- β -methoxynaphthalene, m. p. 100°; 3'-bromo- β -ethoxynaphthalene, m. p. 80°; 1-bromo- β -ethoxynaphthalene, m. p. 66°; 1-chloro- β -ethoxynaphthalene, m. p. 58°; 1:3'-dibromo- β -ethoxynaphthalene, m. p. 94°; 1:3'-chlorobromo- β -ethoxynaphthalene, m. p. 77°; 3'-bromo- β -propoxynaphthalene, m. p. 63·5°; 1-bromo- β -propoxynaphthalene, m. p. 35—36°; 1:3'-dibromo- β -propoxynaphthalene, m. p. 75°; and 1:3'-chlorobromo- β -propoxynaphthalene, m. p. 60·5°.

148. "On the determination of transition temperatures." By H. M. Dawson, Ph.D., B.Sc., and P. Williams, B.Sc.

While the influence of temperature on homogeneous and heterogeneous equilibrium is a continuous one, the so-called 'condensed systems' are characterised by the existence of a transition temperature. At this temperature, the system suddenly undergoes a complete change. The second form of the system, which is stable at the higher temperature, is entirely retransformed into the first on lowering the temperature below that of the transition point.

Various methods have been employed for the determination of such transition temperatures, for example, the dilatometric, the thermometric, and the various identity methods. The latter depend upon the fact that the saturated solutions of the systems which are capable of mutual transformation become identical at the transition temperature. In consequence of this, the properties of the saturated solutions corresponding to the various solubility curves emanating from the transition point assume the same value at this temperature. In choosing a suitable property of the saturated solution for investigation, attention must be paid to the three following points: (1) the property in

question must be measurable accurately and rapidly; (2) it must show a notable variation for small changes in the composition of the saturated solution; (3) there should, if possible, be no loss in the quantity of the saturated solution as a result of the measurement.

The densities and electric conductivities of saturated solutions have been investigated by the authors with a view to determining transition temperatures. The density measurements were carried out with the saturated solution of sodium sulphate. The curves obtained by plotting the density intersect at a wide angle at 32.4° corresponding to the transformation of the decahydrate into the anhydrous salt at this temperature.

Conductivity measurements were also carried out with this salt; as in the case of the density, two curves intersecting at about 32.5° were obtained.

The change in direction of the curve at this temperature is not so great as was expected; this is, however, explicable on the ground that the solutions are so concentrated.

A second series of experiments was carried out with thorium sulphate, the nonahydrate of which, according to Roozeboom, changes into the tetrahydrate at about 43° . The concentration of the saturated solution at the transition temperature is, in this case, only about one-third normal.

On plotting the conductivity on a diagram, two curves are obtained intersecting at about 48° . To confirm this result, the transition temperature has been determined dilatometrically and tensimetrically, by which methods 46.5° and 47.5° were obtained. Roozeboom's determination of 43° would therefore appear to be somewhat too low. The authors point out the availability of the above methods of determination in cases where other methods cannot be used with advantage.

149. "Constitution of amarine, of its supposed dialkyl- and diacyl-derivatives, and of isoamarine." By Francis R. Japp, F.R.S., and James Moir, M.A., B.Sc.

The authors find that Claus and Elbs's "dibenzylamarine" (m. p. $139-140^{\circ}$) has in reality the composition represented by the formula $C_{21}H_{15}(C_7H_7)_2N_2O$, and is *benzoyl-s-dibenzyl-i-diphenylethylenediamine*, $C_6H_5 \cdot CH \cdot N(C_7H_7) \cdot CO \cdot C_6H_5$. It may be obtained, along with a di- $C_6H_5 \cdot CH \cdot NH \cdot C_7H_7$ benzoyl derivative (m. p. 268°), by the action of benzoic chloride on Grossmann's *s-dibenzyl-i-diphenylethylenediamine*, thus proving its constitution. This dibenzoyl derivative, melting at 268° , may also be obtained by introducing a benzoyl group into "dibenzylamarine." Claus and Elbs's "dimethylamarine" (m. p. 146°) is in reality

the corresponding *benzoyl-s-dimethyl-i-diphenylethylenediamine*, and Borodine's "diethylamarine" (m. p. 110—115°; the authors find 125°) is the corresponding diethyl derivative.

When benzoyl-*s*-dibenzyl-*i*-diphenylethylenediamine hydrochloride is heated to 220°, it parts with water, yielding dibenzylamaronium chloride,
$$\begin{array}{c} \text{C}_6\text{H}_5 \cdot \text{CH} \cdot \text{N}(\text{C}_7\text{H}_7) \cdot \text{CO} \cdot \text{C}_6\text{H}_5 \\ \text{C}_6\text{H}_5 \cdot \text{CH} \cdot \text{N}^v(\text{C}_7\text{H}_7)\text{H}_2\text{Cl} \end{array} = \begin{array}{c} \text{C}_6\text{H}_5 \cdot \text{CH} - \text{N}(\text{C}_7\text{H}_7) \\ \text{C}_6\text{H}_5 \cdot \text{CH} \cdot \text{N}^v(\text{C}_7\text{H}_7)\text{Cl} \end{array} \gg \text{C} \cdot \text{C}_6\text{H}_5 + \text{H}_2\text{O},$$
 a reaction which proves conclusively the constitution of the dialkylamaronium salts.

Dibenzylamaronium chloride gives a dichromate of the formula $(\text{C}_{35}\text{H}_{31}\text{N}_2\text{Cl})_2, \text{H}_2\text{Cr}_2\text{O}_7$ (m. p. 173°) which, when boiled with glacial acetic acid and a little hydrochloric acid, yields *dibenzyllophonium chloride*, showing that the latter substance has the constitution
$$\begin{array}{c} \text{C}_6\text{H}_5 \cdot \text{C} - \text{N}(\text{C}_7\text{H}_7) \\ \text{C}_6\text{H}_5 \cdot \text{C} \cdot \text{N}^v(\text{C}_7\text{H}_7)\text{Cl} \end{array} \gg \text{C} \cdot \text{C}_6\text{H}_5,$$
 instead of, as suggested by Japp and Davidson,
$$\begin{array}{c} \text{C}_6\text{H}_5 \cdot \text{C} \cdot \text{N}^v(\text{C}_7\text{H}_7)_2\text{Cl} \\ \text{C}_6\text{H}_5 \cdot \text{C} - \text{N} \end{array} \gg \text{C} \cdot \text{C}_6\text{H}_5.$$

The authors regard amarine as *2-phenyl-4 : 5-cis-diphenyl-4 : 5-dihydro-imidazole*,
$$\begin{array}{c} \text{H} \\ \text{C}_6\text{H}_5 \cdot \text{C} \cdot \text{NH} \\ \text{C}_6\text{H}_5 \cdot \text{C} - \text{N} \end{array} \gg \text{C} \cdot \text{C}_6\text{H}_5,$$
 employing the numbering of the

imidazole ring adopted by M. M. Richter. A formula identical with the foregoing, excepting that the configuration was not indicated, was put forward by Claus.

Amarine is thus a meso-form derived from Grossmann's *i*-diphenylethylenediamine (m. p. 120—121°), which this author obtained by the reduction of amarine.

The authors show that Snape and Brooke's isoamarine is *2-phenyl-4 : 5-trans-diphenyl-4 : 5-dihydroimidazole*—the corresponding racemic form. With Professor Snape's permission, they reduced isoamarine with sodium in boiling alcohol, and obtained, as in Grossmann's analogous experiment with amarine, a benzylidene derivative, which on hydrolysis with acids, gave benzaldehyde and a base—in this case Feist's *τ*-diphenylethylenediamine (m. p. 90—92°). Isoamarine is thus related to Feist's base in the same way as amarine to Grossmann's. Feist's base (prepared by the reduction of *α*-benzildioxime), when heated with benzoic acid at 170—180°, yielded isoamarine, thus confirming the foregoing view as to the constitution of the latter compound. Amarine benzoate undergoes no change at this temperature.

Isoamarine may be readily prepared by fusing amarine with sodium, or by heating amarine hydrochloride above its melting point.

The authors find that Claus and Scherbel's supposed dibenzoylamarine is identical with Grossmann's *s*-dibenzoyl-*i*-diphenylethylenediamine,

and that Bahrmann's supposed diacetylamarine is acetylbenzoyl-*i*-diphenylethylenediamine. This removes the supposed evidence for the symmetrical or di-imidic formula of amarine.

The authors have made a detailed study of the reactions of the supposed dibenzylamarine, the results of which confirm the foregoing views as to its constitution.

150. "The atomic weight of nitrogen." By G. Dean, B.A.

The work of which an account is given in this paper is in continuation of that of which a preliminary notice has already been communicated to the Society (*Proc.*, 1898, 14, 174). After giving a summary of the results of previous workers, the author deduces a mean value from them of 14.034 for the atomic weight of nitrogen, but points out that the means of the determinations by chemical methods of individual workers vary from 13.975 (Pelouze) to 14.05 (Stas). The ratio of the densities of oxygen and nitrogen as determined by Lord Rayleigh and by M. Leduc is 16 : 14.003. These variations seemed to be too great, so it was thought that it would be both important and interesting to try a new method which would involve as few atomic weights as possible, and only those which are known with the highest accuracy. Silver cyanide was selected as the compound containing nitrogen, and the ratio between a given mass of it and that of the potassium bromide required for the complete precipitation of the silver contained in it determined with all the precautions insisted on in such work by Stas. The cyanide was decomposed in some cases by dissolving it in nitric acid, in other experiments sulphuric acid. The ratio between the purest silver and the sample of potassium bromide used was carefully determined, so that the ratio found was really Ag : AgCN. This was found to be 107.93 : 133.962, whence $CN = 26.032$ and $N = 14.031$ if $C = 12.001$.

CERTIFICATES OF CANDIDATES FOR ELECTION AT THE NEXT BALLOT.

N.B.—The names of those who sign from “General Knowledge” are printed in *italics*.

The following Candidates have been proposed for election. A ballot will be held on Thursday, December 7th, 1899.

Anderson, James William,

1, Preston Villas, Halling, Kent.

Analytical Chemist. Student, Rutherford College, Newcastle-on-Tyne, in Chemistry and Metallurgy, &c. Assistant Chemist for 12 years, Messrs. Rio Tinto Co., Limited, at Jarrow-on-Tyne, in the extraction of copper, silver, gold, lead, &c., and smelting and refining of copper, &c. Head Chemist, Messrs. Hilton, Anderson, Brooks and Co., Limited, Cement Manufacturers, 6, Upper Thames Street, London, and elsewhere.

George Thudichum.

Robt. G. Grimwood.

W. J. Dibdin.

Leopold Mandeville Deane.

A. Stanley Fox.

Armitage, Francis Paul,

High House, Brook Green, Hammersmith.

Assistant Science Master at St. Paul's School. First Class Honours in Chemistry at Oxford, 1898.

W. W. Fisher.

V. H. Veley.

John Watts.

J. E. Marsh.

Wyndham R. Dunstan.

Armstrong, Frederick William,

The Hill, Langport, Somerset.

Science Master and Evening Lecturer. Past Royal Exhibitioner at the Royal College of Science. Associate of the Royal School of Mines.

T. E. Thorpe.

W. Palmer Wynne.

F. R. Japp.

A. E. Tutton.

T. H. Walker.

Beesley, Frederic Arnold,
Bank House, Wirksworth, Derby.

Lecturer and Teacher of Chemistry and Physics at the Ashby-de-la-Zouch Grammar School. For 5 years I was a student of Chemistry at University College, Nottingham, where I carried on my work considerably beyond the standard of the London B.Sc. I hold this degree in Chemistry and in Physics with Honours. I have been teaching Chemistry (Theoretical and Practical) for the past two years.

Frank Clowes.	J. J. Sudborough.
J. Bernard Coleman.	R. M. Caven.
R. Lloyd Whiteley.	E. T. Shelbourn.

Chapman, Edgar Marsh,
17, Bloomsbury Square, London, W.C.

Holder of the Burroughs Scholarship in the Pharmaceutical Society's Laboratory. Have studied Chemistry for two years under Professor J. Norman Collie, and passed the Pharmaceutical Society's examination; have been engaged for a year in Research work; joint author of paper on "Homocamphoronic and Camphononic Acids," *Proc.*, 1899, 15, 159.

J. Norman Collie.	M. Carteighe.
A. Lapworth.	Thomas Tickle.
John E. Mackenzie.	

Dewhirst, John Arthur,
125, Mount View Road, Stroud Green, N.

Chemist. Studied at Bradford Technical College, Yorkshire College, Leeds, and at Pharmaceutical Society's School. Three times Medallist at latter institution. Formerly Assistant in Laboratory of Dr. Attfield, F.R.S. Latterly Demonstrator of Chemistry, School of Pharmaceutical Society. Now Chemist to Messrs. Geo. Curling, Wyman and Co., Bunhill Row.

John Norman Collie.	Wyndham R. Dunstan.
Arthur Lapworth.	Arthur Smithells.

Wm. Ackroyd.

Dougall, James Dick,
Millom, Cumberland.

Analytical Chemist. Was three years a Student and two years an Assistant with Messrs. Tatlock and Thomson, of Glasgow. Since then have been head Chemist in large works in Cumberland, and have contributed one or two small papers to the *Analyst* and local societies in Glasgow.

R. R. Tatlock.	Horatio Ballantyne.
R. T. Thomson.	John Clark.
W. Rintoul.	Wm. T. Thomson.

Dudderidge, Frank Rawlinson,
45, Sidney Grove, Newcastle-on-Tyne.

Analytical and Pharmaceutical Chemist. Principal of the North of England School of Chemistry, 55, Northumberland Street, Newcastle-on-Tyne, where I lecture on Chemistry daily. Medallist in Chemistry at the South London School of Chemistry (1890—91). For some time Analytical Chemist with Messrs. Brady and Martin, Manufacturing Chemists, Newcastle-on-Tyne.

P. Phillips Bedson.

Geo. F. Merson.

Fredk. Gilderdale.

W. A. H. Naylor.

Thomas Tyrer.

Fermor, Herbert Frederick Francis Burdett,
15, Ansdell Road, Peckham, London, S.E.

Analytical Chemist. Mainly educated in Science by private study. Student at Goldsmiths' Institute, then Demonstrator in the Chemical Department at the same institution. Lecturer on Chemistry to London School Board. Assistant Analyst, Chemical and Gas Department, London County Council. Medallist in Chemistry, Science and Art Department.

Frank Clowes.

R. Grimwood.

William Jackson Pope.

J. H. Coste.

A. G. Bloxam.

Charles J. S. Makin.

Gurney, Elliott Henry,
Albert Street, Marrickville, New South Wales.

Assistant Chemist, Department of Agriculture, New South Wales. Seven years assistant to Mr. F. B. Guthrie, Chemist to Department of Agriculture, N.S.W. Author of "Notes on Colouring Matter of *Eriococcus Eucalypti*," and "The Wax of *Ceroplastes Rubens*," (published in Vol. VII. *Australian Association for Advancement of Science*). Also, with Mr. Guthrie, "Notes on Milling Qualities of Different Varieties of Wheat," and "Analyses of Commercial Fertilisers obtainable in N.S.W.," and of other papers in the *Agricultural Gazette*, N.S.W.

William M. Hamlet.

H. G. Smith.

F. B. Guthrie.

W. M. Doherty.

A. Liversidge.

J. A. Schofield.

Will. A. Dixon.

Kay, Percy,
3, Phenc Street, Chelsea, S.W.

Senior Demonstrator, S.W. London Polytechnic, Chelsea. Ph.D. in Chemistry of Heidelberg. Fellow of the Institute of Chemistry.

Author of the following papers: "Action of Mustard oils on aromatic acids diacetanilides," "Urethane derivatives and nitro-piperidine."

J. Bernard Coleman.

R. Grimwood.

Frank Clowes.

J. H. Coste.

A. Hunter Boylan.

Kinnersley, Henry Wulff,

4, The Avenue, Keynsham, Somerset.

Student. One year Merchant Venturers' Tech. College, Bristol. Three years Dr. E. H. Cook, Bristol. One year King's College, London. Passed Intermediate Examination of the Institute of Chemistry. Passed Honours Examination in Chemistry of Science and Art.

John M. Thomson.

Patrick H. Kirkaldy.

Herbert Jackson.

Martin Priest.

Ernest H. Cook.

Lange, Ernest Frederick Stephen,

Sunny Nook, Victoria Road, Withington, Manchester.

Steel Works Manager, *i.e.*, Metallurgical Engineer. Practical and Theoretical Research into the Metallurgy of the melting of steel in the Siemens Open Hearth Furnace, the Metallurgy of the various small converter processes for making steel, the mixing of special foundry irons, desulphurisation by means of ferromanganese, &c., &c.

J. E. Stead.

Hugh Ramage.

J. Reddrop.

W. N. Hartley.

H. Frankland.

Leeming, William Thomas,

60, Lomeshaye Road, Nelson.

Science Teacher. Student of Owens College, 1892—1895, in the Honours School of Chemistry, and B.Sc. (Vict. Univ.). Science Master in the Nelson Technical School, and Lecturer in Chemistry in the Nelson Evening School.

H. B. Dixon.

W. H. Perkin, jun.

G. H. Bailey.

J. F. Thorpe.

W. A. Bone.

W. T. Lawrence.

Lett, Stephen Joshua,

(In England), 25, Percy Street, Liverpool.

Assayer and Technical Chemist. Sole charge of Assay Office in Central Africa of Messrs. The North Charterland Exploration Co., Ltd., for past two years (this position I still hold). Sole charge of Assay and Chemical Department of Messrs. The Ripanji Quicksilver

and Silver Mines, Ltd., Ripanji, Servia. Analyst for four years to the Gas and Water Committees of Messrs. The Wallasey Local Board (Cheshire, England). Four years Student Assistant to the late Mr. A. Norman Tate, F.I.C., F.C.S.

Francis Henry Tate.

T. A. Reid.

William J. Butcher.

Edward Davies.

F. E. Bowman.

Lewis, Edward Watkin,

64, Ommaney Road, New Cross, S.E.

Student. Associate of the City and Guilds Institute in the Department of Chemistry. Now Salters' Research Fellow at the Central Technical College.

Henry E. Armstrong.

William A. Davis.

T. M. Lowry.

Edwin C. Jee.

Gerald T. Moody.

McCreath, William D.,

The Plains, Totnes, S. Devon.

Analytical and Technical Chemist. Studied Chemistry first under Dr. C. M. Aikman, of Glasgow. Afterwards assistant for $4\frac{1}{2}$ years to Mr. F. J. Lloyd, during which made a speciality of cider fermentation, assisting Mr. Lloyd in his experiments on cider, and also, during two seasons, in those on cheddar cheese. Now Chemist and Scientific Adviser to Messrs. J. Symons & Co., Cider and Wine Makers, of Totnes.

C. M. Aikman.

Alexander Cameron.

Fredk. J. Lloyd.

Jas. McCreath.

John Heron.

E. R. Moritz.

C. H. Bothamley.

Main, Hugh,

45, The Village, Old Charlton, Kent.

Technical Chemist. B.Sc. (Lond.). Seventeen years Chemist at Messrs. H. Tate & Sons, Ltd., Sugar Refiners, London.

Rudolph Messel.

Arthur R. Ling.

D. Bendix.

Albert Harrison.

B. E. R. Newlands.

Otto Hefner.

Neale, Harry Ainley,

Brentwood, Clothorn Road, Didsbury, Manchester.

Assistant Chemist in dye-works. Studied Chemistry for four years

at Owens College, Manchester. One year's research with Dr. J. F. Thorpe (work not yet published).

H. B. Dixon.

G. H. Bailey.

A. William Gilbody.

J. F. Thorpe.

W. H. Perkin, jun.

Palmer, Thomas Henry,

"Amalfi," Longueville, Sydney, N. S. Wales.

Mining and Metallurgical Engineer. 1896—1897, Analytical Chemist to Royal Commission on Coal Cargoes, Sydney. 1898, Graduated for the Degree of Bachelor of Engineering in Mining and Metallurgy, University of Sydney. 1898, Manager of Gold Extraction Cyanide Works, Peak Hill, N.S. Wales. 1899 and at present, General Manager, Overflow Silver Mine and Metallurgical Works, Bobadah, New South Wales. Author of paper on "The Cyanide Process for the Extraction of Gold," and read before the Sydney University Engineering Society, 11th May, 1898.

A. Liversidge.

C. Walker.

J. A. Schofield.

F. B. Guthrie.

William M. Hamlet.

Pearson, Marchant,

The Grammar School, Bridlington.

Schoolmaster. B.A. (Lond. Univ.), Intermediate B.Sc. (Lond. Univ.) Assist. Science Master for four years, 1895—1899, at the Bradford Grammar School (work chiefly Chemistry); joint author of a school manual on Volc. Analysis.

Arthur Thornton.

Julius B. Cohen.

Arthur Smithells.

J. Maudsley.

J. W. Pallister.

Polkinghorne, Bennett C.

46, Lynette Avenue, Clapham Common, S.W.

B.Sc. Science Master Alleyn's School, Dulwich College; Demonstrator in Chemistry, Battersea Polytechnic; studied Chemistry as a special branch for Science Degree; is principally engaged in teaching Chemistry as above; was also teacher of Chemistry at Tottenham Polytechnic; holds several Certificates, including Honours, Practical Chemistry, from Science and Art Department.

J. H. Robins.

John Wilson.

Thos. J. Cheater.

W. W. S. Nicholls.

C. H. Burge.

Ponthieu, Georges,

Pharmacie Centrale de France, Avenue de Paris, St. Denis
(Seine).

Manufacturing Chemist. Was three years in the Analytical Laboratory and Manufacturing Department of Messrs. Burgoyne, Burbridge and Co., London. Is, and has been for over two years, Scientific Manager of the Chemical Department at the St. Denis Works of the "Pharmacie Centrale de France" (near Paris).

Thos. Farries.

F. M. Mercer.

Theophilus Pitt.

H. Wilson Hake.

Isaac S. Scarf.

Raynor, William Downing,

13, Christ Church Road, Doncaster.

Senior Science Master in the Doncaster Grammar School. B.A. of Hertford College, Oxford, in Natural Science (Chemistry), Honours, 1896. Science Master of the County School, Pembroke Dock, 1896—1898. From September, 1898, to July, 1899, Chemistry Master in the Bradford Grammar School; now Senior Science Master of Doncaster Grammar School.

V. H. Veley.

J. E. Marsh.

John Watts.

W. W. Fisher.

Arthur Thornton.

Roundell, Christopher Foulis,

Guards' Club, Pall Mall, S.W.

2nd Lieutenant, Coldstream Guards. B.A., Balliol College, Oxford, with Honours in Chemistry.

A. Vernon Harcourt.

John Conroy.

Wyndham R. Dunstan.

William E. Moss.

D. H. Nagel.

Russell, William,

Thetford, Norfolk.

Analytical Chemist to Matthew's Kentish White Lead Co., East Greenwich. Three years course at the Royal College of Science, S. Kensington. Science Master (Chemistry) at the Grammar School, Wirksworth. At present Chemist to Matthew's Kentish White Lead Co., Morden Wharf, East Greenwich.

William A. Tilden

Cecil J. Brooks.

G. Cuthbertson.

Chapman Jones.

Francis Sutton.

Walton, Robert Hawks,

424, Park Road, Moore Park, Sydney.

Analyst and Assayer. Chief Assistant to Dr. Helms, 8, Bridge Street. I have been with Dr. Helms for more than 9 years.

A. Helms.

W. M. Doherty.

William M. Hamlet.

John C. H. Mingaye.

Will. A. Dixon.

Wilson, F. R. Leyland,

Charterhouse, Godalming.

Science Master, Charterhouse. M.A., Oxford. Honours in Final Nat. Science School (Chemistry), 1892. Late Assistant-Master at Dulwich College. Chemistry Master at Charterhouse. Worked under Professor Wislicenus at Leipzig on derivatives of diketohydrindene, results not yet published.

H. Brereton Baker.

John Watts.

W. W. Fisher.

A. Hartridge.

V. H. Veley.

J. E. Marsh.

Wilson, John,

73, Melford Road, Leytonstone, E.

Analytical Chemist. Studied at Robert Gordon's College, Aberdeen ; at Heriot-Watt College, Edinburgh ; under Professor W. H. Perkin, jun., F.R.S., and Professor F. Stanley Kipping, F.R.S. ; and at Finsbury Technical College, under J. Castell-Evans, Esq., F.I.C., F.W. Streatfeild, Esq., F.I.C., and Professor Meldola, F.R.S. Eight years' experience in analysis of oils and fats, soaps, glycerine, and essential oils. Engaged on the staff of the Vinolia Company, Ltd.

Henry Garnett.

Herbert E. Burgess.

W. W. Houlder.

R. Meldola.

F. Mollwo Perkin.

Peter MacEwan.

A. Jamieson Walker.

J. T. Hewitt.

Harold Senior.

The following Certificate was authorised by Council under Bye-law I. (3).

Pye, Frank J.,

Towrang, New South Wales, Australia.

Managing Chemist to the Towrang Acid Works, N.S.W. Four years Assistant Chemist at the Chemical Works of Messrs. Burt, Boulton and Haywood, London. Four years Chemist at Messrs.

Brotherton and Co.'s Tar Works, Leeds. Five years Chemist and Works Manager at the Tar and Ammonia Works of T. H. Harvey, Esq., Plymouth.

Arthur W. Cooke.

Harry W. Dixon.

Robert Hamilton.

E. G. McBretney.

RESEARCH FUND.

A meeting of the Research Fund Committee will be held in December. Applications for Grants, to be made on forms which can be obtained on application to the Assistant Secretary, must be received on or before November 30th.

At the next meeting on Thursday, December 7th, there will be a ballot for the election of Fellows, and the following paper will be communicated by the authors :—

“The oxidation of certain organic acids in presence of iron.” By H. J. H. Fenton, M.A., F.R.S., and H. O. Jones, B.A., B.Sc.

PROCEEDINGS

OF THE

CHEMICAL SOCIETY.

EDITED BY THE SECRETARIES.

Vol. 15.

No. 215.

December 7th, 1899. Professor Thorpe, F.R.S., President, in the Chair.

Certificates were read for the first time in favour of Messrs. Alexander Hutcheon Bennett, 61 London Road, Bromley, Kent; Oscar Joseph Cole, Wivenhoe, Colchester, Essex; Thomas Cuthbert Davison, 49 Victoria Road, New Swindon, Wilts.; Harry Medforth Dawson, Yorkshire College, Leeds; Stephen M. Dixon, University, Fredericton, New Brunswick, Canada; James Foulds, 5 Murray Street, Burnley, Lancashire; Robert W. Gray, 7 Orme Court, Bayswater; Henry Jackson, Downing College, Cambridge; Thomas Goode Joyce, The Smallthorns, Stafford; William Charles Robert Kynaston, 9 Harland Road, Higher Tranmere, Birkenhead; Arthur Robert Laws, 48 Waverley Terrace, Newcastle-on-Tyne; Alan W. Cranbrook Menzies, 11 Howe Street, Edinburgh; Edgar Ford Morris, 69 Shrewsbury Street, Old Trafford, Manchester; Herbert Newall Morris, 48 Lansdowne Road, Crumpsall, Manchester; Ernest Brooks Naylor, 73 Castle Street, Bolton; James Hart-Smith, 4 Edenvale Street, Fulham; Bertram Vincent Storr, 17 York Road, Ilford, Essex; Archie Hugh Strong, Stoneleigh Villa, 63 Herne Hill Road, Camberwell, S.E.; Gustavus Athol Waterhouse, "Ellerslie," Birrell Street, Waverley, N.S.W.; Leonard Philip Wilson, 123 Chadwick Road, East Dulwich, S.E.

A ballot for the election of Fellows was held, and the following were subsequently declared duly elected:—Messrs. James William Anderson; Francis Paul Armitage; Frederick William Armstrong; Frederic Arnold Beesley, B.Sc.; Edgar Marsh Chapman; John Arthur Dewhirst; James Dick Dougall; Frank Rawlinson Duddridge; H. F. F. Burdett Fermor; Elliott Henry Gurney; Percy Kay, Ph.D.; Henry Wulff Kinnersley; Ernest F. Stephen Lange;

William Thomas Leeming, B.Sc.; Stephen Joshua Lett; Edward Watkin Lewis; William D. McCreath; Hugh Main, B.Sc.; Harry Ainley Neale; Thomas Henry Palmer; Marchant Pearson, B.A.; Bennett C. Polkinghorne, B.Sc.; Georges Ponthieu; Frank J. Pye; William Downing Raynor, B.A.; Christopher Foulis Roundell, B.A.; William Russell; Robert Hawks Walton; F. R. Leyland Wilson, M.A.; John Wilson.

Of the following papers, those marked * were read.

- *151. "The oxidation of certain organic acids in presence of ferrous salts." By Henry J. Horstman Fenton, M.A., F.R.S., and H. O. Jones, B.A., B.Sc.**

The oxidation of various organic substances in presence of iron has formed the subject of a considerable number of previous communications, and the observations are now being extended in several directions. The present paper deals with results which have recently been obtained in an extensive study of the behaviour of acids of typical constitution when oxidised by hydrogen peroxide in presence of ferrous salts.

It is shown that, under the conditions of the experiments, the following acids are unacted upon by the reagent: acetic, monochloracetic, oxalic, malonic, succinic, dibromosuccinic, fumaric, maleic; whereas an energetic, and generally immediate, oxidation occurs in the case of the following acids: formic, glycollic, lactic, β -oxybutyric, glyceric, tartronic, tartaric, malic, citric, mucic, saccharic, pyruvic, dioxytartaric, acetylene dicarboxylic, acetone dicarboxylic, pyromucic, benzoic, picric.

The oxidation products obtained are often of considerable interest, and changes can be effected which have not been accomplished by any other means. These oxidation products are being examined, and in the present communication an account is given of the progress of the investigation.

- *152. "Oxalacetic acid." By Henry J. Horstman Fenton, M.A., F.R.S., and H. O. Jones, B.A., B.Sc.**

By the oxidation of malic acid in presence of ferrous salts, the authors obtained a white, crystalline substance having the formula $C_4H_4O_5$, which, on examination, was found to be free oxalacetic acid. The hydrazone crystallises in lustrous prisms, and, when heated with dilute sulphuric acid gives the phenylpyrazoloncarboxylic acid which was obtained by Wislicenus and by Buchner from the ethyl and methyl esters. Further identification is afforded by the formation of the

methyl ester and its hydrazone, by the colour reaction with ferric chloride, and by the formation of pyruvic acid when an aqueous solution of the acid is heated.

***153. "Determination of the constitution of fatty acids. Part II."
By Arthur William Crossley and Henry Rondel Le Sueur.**

In continuation of their work (*Trans.*, 1899, 75, 161), the authors have prepared ethylisopropylacetic acid from ethylisopropylmalonic acid, and have investigated it by their method.

Ethylisopropylmalonic acid crystallises from benzene in glistening needles melting at $131-131.5^{\circ}$; the *ethyl* salt is a colourless liquid boiling at $232-233^{\circ}$.

Ethylisopropylacetic acid, $C_2H_5 \cdot CH(C_3H_7) \cdot COOH$, prepared by the elimination of carbon dioxide from ethylisopropyl malonic acid, is a disagreeable smelling liquid boiling at 203° . The *ethyl* salt is a colourless liquid boiling at $164-165^{\circ}$ (765 mm.), and possessing a characteristic smell; the *amide* crystallises from light petroleum in silky needles melting at 134° ; the *anilide* separates from light petroleum in clusters of small, glistening needles melting at $114-115^{\circ}$; and the *paratoluidide* forms feathery needles melting at 123° .

Ethyl α -bromethylisopropylacetate is a mobile liquid boiling at $135-136^{\circ}$ (59 mm.) possessing a pungent smell somewhat resembling peppermint. When treated with diethylaniline, hydrogen bromide is eliminated in two ways, giving rise to a liquid having a marked odour of peppermint, and boiling at $175-180^{\circ}$. It consists of a mixture of *ethyl dimethylethylacrylate* and *ethyl methylisopropylacrylate*. On saponification, a mixture of the corresponding acids is obtained boiling constantly at 136° (55 mm.).

When this mixture is oxidised, first with potassium permanganate and then potassium dichromate, the products are, as expected, acetone, acetic, propionic, and isobutyric acids; thus proving that two unsaturated ethyl salts are formed by the action of diethylaniline on ethyl α -bromethylisopropylacetate.

Applying these results to the determination of the constitution of the original acid, having the formula $C_7H_{14}O_2$, since acetone is produced on oxidation, the group $(CH_3)_2C:$ must be attached to the α -carbon atom in the unsaturated acid, the double bond being produced by elimination of a bromine atom from the α -carbon atom, and a hydrogen atom from an adjacent carbon atom, hence $(CH_3)_2C:C \cdot COOH$ represents the grouping of five of the seven carbon atoms. The two remaining carbon atoms must be attached to the α -carbon atom, and as propionic acid was obtained, they must have been present as an ethyl group, therefore the formula of the unsaturated acid is

$(\text{CH}_3)_2\text{C}:\text{C}(\text{C}_2\text{H}_5)\cdot\text{CO}_2\text{H}$, and $(\text{CH}_3)_2\text{CH}\cdot\text{CH}(\text{C}_2\text{H}_5)\cdot\text{CO}_2\text{H}$ that of the original fatty acid.

The presence of acetic and isobutyric acids is accounted for by the oxidation of the second unsaturated acid produced, namely, methylisopropylacrylic acid.

***154. "The reaction between sulphuric acid and potassium ferrocyanide." By R. H. Adie, M.A., B.Sc., and K. C. Browning, B.A.**

The authors have made a quantitative investigation of the action of sulphuric acid of concentrations varying from that of H_2SO_4 (98 per cent.) to $\text{H}_2\text{SO}_4, 8\text{H}_2\text{O}$ on potassium ferrocyanide with the following results.

The salt dissolves in acid of strengths corresponding to H_2SO_4 and $\text{H}_2\text{SO}_4, \text{H}_2\text{O}$, with the formation of potassium sulphate and hydroferrocyanic acid; there is only a slow and incomplete formation of carbon monoxide.

In acid of the strength represented by $\text{H}_2\text{SO}_4, 2\text{H}_2\text{O}$, the decomposition of the salt results in the formation of carbon monoxide; this reaction accounts for all the cyanogen in the salt.

With more dilute acid of the composition of from $\text{H}_2\text{SO}_4, 4\text{H}_2\text{O}$ to $\text{H}_2\text{SO}_4, 10\text{H}_2\text{O}$, the products are hydrocyanic acid and Everitt's salt, $\text{K}_2\text{Fe}_2\text{Cy}_6$. At the latter dilution, all the cyanogen in the salt appears as hydrocyanic acid, while the formation of carbon monoxide practically ceases with acid of $\text{H}_2\text{SO}_4, 4\text{H}_2\text{O}$ strength.

The authors discuss the mechanism of the reaction (i) through the formation and hydrolysis of hydroferrocyanic acid by means of the dilute sulphuric acid; (ii) through the action of the potassium sulphate first formed on the hydroferrocyanic acid, with the intermediate formation of Everitt's salt. The latter reaction only takes place in fairly concentrated solutions, whilst the former alone occurs with acids more dilute than that represented by $\text{H}_2\text{SO}_4, 10\text{H}_2\text{O}$. Other conditions influencing the reactions are also fully discussed.

***155. "The sulphates of bismuth." By R. H. Adie, M.A., B.Sc.**

The author has investigated the conditions of formation and limits of existence of the sulphates of bismuth, and has found that from sulphuric acid of any strength between those represented by $\text{H}_2\text{SO}_4, 6\text{H}_2\text{O}$ and $\text{H}_2\text{SO}_4, 12\text{H}_2\text{O}$, a basic bismuth sulphate having the formula $5\text{Bi}_2\text{O}_3, 11\text{SO}_3, 17\text{H}_2\text{O}$ crystallises out; if between $\text{H}_2\text{SO}_4, 3\text{H}_2\text{O}$ and $\text{H}_2\text{SO}_4, 5\text{H}_2\text{O}$, the sulphate may be represented as $\text{Bi}_2\text{O}_3, 4\text{SO}_3, 7\text{H}_2\text{O}$, and if the strength be between $\text{H}_2\text{SO}_4, \text{H}_2\text{O}$ and $\text{H}_2\text{SO}_4, 2\text{H}_2\text{O}$, the salt obtained has the composition $\text{Bi}_2\text{O}_3, 4\text{SO}_3, 3\text{H}_2\text{O}$. From sulphuric acid

itself, the sulphate which crystallises out at temperatures above 170° has the formula $\text{Bi}_2\text{O}_3, 4\text{SO}_3, \text{H}_2\text{O}$; if below 170° , $\text{Bi}_2\text{O}_3, 4\text{SO}_3, 10\text{H}_2\text{O}$.

This temperature 170° is that at which the acid sulphates are decomposed when heated in an air-bath, the normal bismuth sulphate, $\text{Bi}_2\text{O}_3, 3\text{SO}_3$ being formed.

156. "On sulphates of the form $\text{R}_2\text{SO}_4, 2\text{MSO}_4$, especially those of isometric crystallisation." By F. R. Mallet.

During an examination of langbeinite ($\text{K}_2\text{SO}_4, 2\text{MgSO}_4$), from the Punjab (*Min. Mag.*, 1899, 12, 159), the author noticed that the mineral, which fuses at a red heat, on cooling solidifies to a more or less distinctly crystalline mass. This observation naturally suggested that the salt might probably be artificially produced by fusing potassium and magnesium sulphates together in the proper proportions. The crystalline mass obtained on cooling the fused sulphates contains especially in the cavities abundant octahedral crystals sometimes over a millimetre in diameter.

As it seemed probable that other salts of similar constitution might be produced in the same way, the author has prepared the following sulphates of isometric symmetry: $\text{K}_2\text{SO}_4, 2\text{MgSO}_4$; $\text{K}_2\text{SO}_4, 2\text{ZnSO}_4$; $\text{K}_2\text{SO}_4, 2\text{MnSO}_4$; $\text{K}_2\text{SO}_4, 2\text{NiSO}_4$; $\text{K}_2\text{SO}_4, 2\text{CoSO}_4$; $\text{Rb}_2\text{SO}_4, 2\text{MgSO}_4$. Measurements of the angles of the crystals, and partial, or complete, analyses of the above salts are given; their mode of decomposition by absorption of water is also described.

Mixed crystals of isometric symmetry containing more than two of the above metals have also been produced, as well as various anisotropic salts, which have not as yet been examined in detail.

157. "Reactions of the so-called dibenzylamarine." By Francis R. Japp, F.R.S., and James Moir, M.A., B.Sc.

In a recently published note (*Proc.*, 1899, 15, 211), the authors showed that the compound melting at $139-140^{\circ}$, obtained by Claus and Elbs (*Ber.*, 1880, 13, 1420) by the action of potassium hydroxide on dibenzylammonium chloride, and described as dibenzylamarine, is in reality benzoyl-*s*-dibenzyl-*i*-diphenylethylenediamine, $\text{C}_6\text{H}_5 \cdot \text{CH} \cdot \text{N}(\text{C}_7\text{H}_7) \cdot \text{CO} \cdot \text{C}_6\text{H}_5$. The following are various experimental results obtained in the study of this substance.

Action of nitrous acid.—This yields, as chief product, a nitroso-compound, $\text{C}_{21}\text{H}_{17}(\text{C}_7\text{H}_7)_2\text{N}_2(\text{NO})\text{O}$ (dimorphous: short needles, m. p. 166° ; and oblong laminae, m. p. 168°), together with *dibenzylammonium nitrate*, $\text{C}_{21}\text{H}_{17}(\text{C}_7\text{H}_7)_2\text{N}_2 \cdot \text{NO}_3$, and a little lophine. The second of

these three compounds was also prepared from dibenzylamaronium chloride and silver nitrate, thus proving its constitution. When "dibenzylamarine" nitrate, $C_{21}H_{18}(C_7H_7)_2N_2O, HNO_3$, was heated at 185° , it was converted into a mixture of dibenzylamaronium nitrate and the foregoing nitroso-compound. *Dibenzylamaronium nitrite* (from the quaternary chloride and silver nitrite) is an uncrystallisable gum, quite distinct from the isomeric nitroso-compound.

Reduction with hydriodic acid.—By boiling "dibenzylamarine" with hydriodic acid (sp. gr. 1.7) for some hours, the following products were obtained: as chief product, *benzoylbenzyl-i-diphenylethylenediamine*, $C_6H_5 \cdot \underset{\text{CO} \cdot C_6H_5}{\underset{|}{CH}} \cdot NH \cdot C_7H_7$ (minute needles, m. p. 218° , basic, and yielding $C_6H_5 \cdot \underset{C_7H_7}{\underset{|}{CH}} \cdot NH \cdot C_7H_7$ a nitroso-compound, m. p. 246°); *benzyl-i-diphenylethylenediamine*, $C_6H_5 \cdot \underset{NH_2}{\underset{|}{CH}} \cdot NH \cdot C_7H_7$ (slender needles, m. p. 90° , converted by benzoic chloride into the foregoing compound melting at 218°); and, further, dibenzyl, benzylic iodide, benzoic acid, benzylamine, and ammonia.

Action of sodium in boiling alcohol.—An almost quantitative yield of Grossmann's *s*-dibenzyl-*i*-diphenylethylenediamine (*Ber.*, 1889, 22, 2301) was obtained.

Action of potassium hydroxide.—No action takes place in alcoholic solution at 150° , but on fusing the compound with potassium hydroxide, it yielded the foregoing *s*-dibenzyl-*i*-diphenylethylenediamine, together with benzyllophine and a crystalline, non-basic substance melting at 128° , which gave figures agreeing with the formula $C_{28}H_{24}N_2O$.

Oxidation.—The authors confirmed Claus's observation that "dibenzylamarine" is not altered by boiling with chromium trioxide in glacial acetic acid solution, but found that when a little concentrated hydrochloric acid was added to the mixture, oxidation took place on boiling, and benzoylbenzyl-*i*-diphenylethylenediamine, $C_{28}H_{26}N_2O$ (m. p. 218°)—already obtained in the reduction with hydriodic acid—was formed.

Action of heat.—The chief products were lophine and benzyllophine.

158. "Note on iso-amarine." By H. Lloyd Snape, D.Sc., Ph.D.

As Japp and Moir have recently published (*Proc.*, 1899, 15, 211) their reasons for regarding the isomeride of amarine described by Brooke and the author (*Trans.*, 1899, 75, 208) as a racemic form of amarine, the author wishes to report that he has succeeded in separating this isomeride, by means of tartaric acid, into two varieties of equal and opposite optical activity. The author hopes to give a detailed account of these and other experiments on iso-amarine at an early date.

159. "On the preparation of benzene azo-orthonitrophenol." By J. T. Hewitt, M.A., D.Sc.

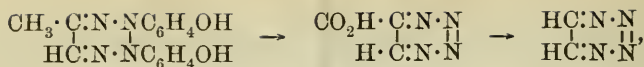
Noelting (*Ber.*, 1887, 20, 2997) has observed that the nitration of benzeneazophenol in a strong sulphuric acid solution leads to the formation of paranitrobenzene azophenol, $\text{NO}_2 \cdot \text{C}_6\text{H}_4 \cdot \text{N} : \text{N} \cdot \text{C}_6\text{H}_4 \cdot \text{OH}$. The author of the present communication finds that by nitrating benzeneazophenol (10 grams) with dilute nitric acid [20 c.c. nitric acid (sp. gr. 1.36) and 60 c.c. water] at 40° , the product of the reaction is benzeneazo-orthonitrophenol, $\text{C}_6\text{H}_5 \cdot \text{N} : \text{N} \cdot \text{C}_6\text{H}_3(\text{NO}_2)(\text{OH})$, m.p. 128.5° (corr.). This difference in behaviour can be readily explained since Noelting nitrated a sulphate of benzeneazophenol, which is probably a derivative of quinone phenylhydrazone, $\text{C}_6\text{H}_5 \cdot \text{NH} \cdot \text{N} : \text{N} \cdot \text{C}_6\text{H}_4 \cdot \text{O}$, whilst the author of the present paper chose nitric acid of such a dilution as to exclude salt formation and hence nitrated benzeneazophenol, $\text{C}_6\text{H}_5 \cdot \text{N} : \text{N} \cdot \text{C}_6\text{H}_4 \cdot \text{OH}$, itself. The result is not compatible with Hantzsch's formulation of the azophenols as quinone-hydrazones when in the free state (*Ber.*, 1899, 32, 3089), since, whilst phenols are more readily substituted than benzene nuclei not containing hydroxyl or amino-groups, on the other hand amino-derivatives of benzene are certainly more easily substituted than quinones. Certain derivatives of benzeneazo-orthonitrophenol are described in the paper.

160. "Some new osazones and tetrazones." By Harold A. Auden.

None of the three possible isomeric forms of tetrazine (which may be described, according to the relative positions of the ring components, as *v*-, *s*-, or α -tetrazines) has yet been isolated. Derivatives of the first of these are represented in the osotetrazones obtained by Pechmann by the oxidation of osazones (*Ber.*, 1888, 21, 2751). A benzene derivative has also been obtained by Hempel (*J. pr. Chem.*, 41, 176), and perhaps the substances named diazohydrides by Zincke (*Ber.*, 1886, 19, 1451; 1888, 21, 543) belong to this class.

Representatives of *s*-tetrazine have been obtained by Ruhemann (*Trans.*, 1888, 53, 850; 1889, 55, 242; 1890, 57, 50) and Pinner (*Ber.*, 1893, 26, 2126; 1894, 27, 984, 3273). Ruhemann (*Trans.*, 1899, 75, 1131) has obtained a dihydro-derivative of *s*-tetrazine ("tetrazoline") from monoformylhydrazine, and Pellizzari (*Atti R. Acad. Lincei*, [v], 1899, 8, 327) from diformylhydrazine.

The author has prepared certain osazones and tetrazones with a view to obtaining from them, by a process of oxidation, *v*-tetrazine, $\text{H} \cdot \text{C} : \text{N} \cdot \text{N} \cdot \text{N} \cdot \text{N}$. The various stages of the oxidation may probably be represented by the formulæ



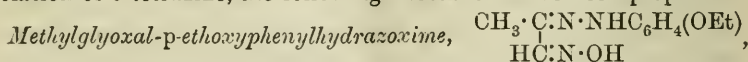
similar to those in the cases of osotriazole (*Annalen*, 1891, 262, 303), tetrazole (*Ber.*, 1895, 28, 1688), and triazole (*Ber.*, 1885, 18, 1550, 2907).

The methods which may be used for the preparation of the substances dealt with in the paper are as follows: (1) The action of nitrosoacetone on hydrazines, with the intermediate formation of hydrazoximes. (2) The interaction of diketones and hydrazines. In the former case, it is not necessary to isolate the nitrosoacetone, but by so doing the reaction is more under control and the yield consequently increased by 1 to 2 per cent. In the latter method, the re-

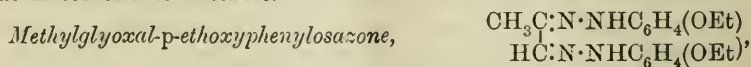
action may be thus represented by $\frac{\text{X}-\text{C}=\text{O}}{\text{X}-\text{C}=\text{O}} + \frac{\text{H}_2\text{N} \cdot \text{NH}-\text{X}}{\text{H}_2\text{N} \cdot \text{NH}-\text{X}}$, yielding

the osazone which, by careful oxidation by means of dilute acetic acid and potassium dichromate or by amyl nitrite, loses two atoms of hydrogen, forming the corresponding tetrazone. The latter method gave better yields, the hydrazoximes frequently decomposing with the production of uninviting, resinous products. In attempting to oxidise the tetrazones, further difficulties have been met with, due partly to their great stability, and partly to the difficulty in some cases of producing the tetrazone from the osazone. The actions of various oxidising agents have been studied, especially those of potassium permanganate in alkaline solution at 80—100°, and of amyl nitrite. It may here be pointed out that oxidation in acid solution is excluded because of the tendency of tetrazones to form triazole derivatives as shown by Pechmann. A mixed osazone was also prepared, as it seemed probable that this might yield a 'tetrazolium' on oxidation similar to the product obtained by Pechmann and Wedekind (*Ber.*, 1894, 27, 320), and that this in turn might yield further interesting products.

Although the experiments as yet carried out have not led to the isolation of *v*-tetrazine, the following substances have been prepared:



brownish-yellow plates, with golden-yellow reflex, melting at 104—106°, with rapid decomposition. It can be recrystallised from methyl alcohol, but in solution is unstable.



reddish-yellow needles, m. p. 135°. With strong sulphuric acid, it gives deep-green solution.

Methylglyoxal-p-ethoxyphenylosotetrazone,
$$\begin{array}{c} \text{CH}_3 \cdot \text{C} \cdot \text{N} \cdot \text{N} \cdot \text{C}_6\text{H}_4(\text{OEt}) \\ | \quad | \\ \text{HC} \cdot \text{N} \cdot \text{N} \cdot \text{C}_6\text{H}_4(\text{OEt}) \end{array}$$

crystallises in Bordeaux-red needles, which cannot be distinguished in shade from those of methylglyoxalosotetrazone. It dissolves in strong hydrochloric acid with indigo-blue coloration, which disappears on heating; with strong sulphuric acid it gives a similar coloration, rapidly becoming green. It is not attacked by alkaline potassium permanganate in the cold, and only with difficulty at 100°.

Diazosalicylic acid, $\text{C}_6\text{H}_3 \begin{array}{l} \nearrow \text{OH} \text{ (2)} \\ \nearrow \text{COO} \text{ (1)} \\ \searrow \text{N} \cdot \text{N} \text{ (5)} \end{array}$ and $\text{C}_6\text{H}_3 \begin{array}{l} \nearrow \text{OH} \\ \nearrow \text{CO}_2\text{H} \\ \searrow \text{N} \cdot \text{N} \cdot \text{Cl} \end{array}$. The

former explodes at 155°, the latter about the same temperature, decomposition generally beginning about 10° lower. The chloride loses hydrogen chloride in the desiccator over soda and when exposed to the air. The free diazo-compound varies in shade from yellow to greenish-yellow; the chloride forms nearly colourless needles. If only gently heated, both may be recrystallised from water.

Potassium diazosalicylic acid sulphonate, $\text{C}_6\text{H}_3(\text{OH})\text{COOK} \cdot \text{N} \cdot \text{N} \cdot \text{SO}_3\text{K}$, is a fairly stable compound which may be recrystallised from water, and dried at 100°. It crystallises in yellow plates.

Hydrazine salicylic acid, $\text{C}_6\text{H}_3 \begin{array}{l} \nearrow \text{CO}_2\text{H} \text{ (1)} \\ \nearrow \text{OH} \text{ (2)} \\ \searrow \text{NH} \cdot \text{NH}_2 \text{ (5)} \end{array}$. This is a slightly

brown amorphous powder which melts at 148°. The hydrochloride crystallises in snowy needles which char at 150°. It reduces Fehling's solution slowly in the cold and gives a white, crystalline hydrazone with benzaldehyde.

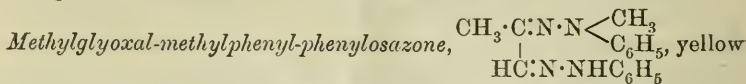
Methylglyoxal-salicylic acid osazone,
$$\begin{array}{c} \text{CH}_3 \cdot \text{C} \cdot \text{N} \cdot \text{NHC}_6\text{H}_3(\text{OH})(\text{COOH}) \\ | \quad | \\ \text{HC} \cdot \text{N} \cdot \text{NHC}_6\text{H}_3(\text{OH})(\text{COOH}) \end{array}$$

a bright yellow, crystalline powder, m. p. 192°. It gives a dark green coloration with ferric chloride. The corresponding hydrazoxime could not be isolated, and probably does not exist, as on using only one molecule of hydrazine the osazone was formed.

Acetyl-propionylsalicylic acid osazone, $\text{C}_2\text{H}_5 \begin{array}{c} \text{CH}_3 \cdot \text{C} \cdot \text{N} \cdot \text{NHC}_6\text{H}_3(\text{OH})(\text{COOH}) \\ | \quad | \\ \text{C}_2\text{H}_5 \cdot \text{C} \cdot \text{N} \cdot \text{NHC}_6\text{H}_3(\text{OH})(\text{COOH}) \end{array}$, may be obtained in very small, yellow crystals by adding water to its solution in alcohol.

On boiling the crude product with alcohol, a yellow residue was invariably left; this residue melted at 220°, but yielded the same numbers on analysis as the more soluble portion which melted at 197°, and is possibly a stereoisomeride. This substance is apparently attacked by oxidising agents, but it does not give the osazone reaction. It yielded, on oxidation with potassium permanganate or

potassium ferricyanide, small amounts of a white, crystalline substance which gave a characteristic wine red coloration with ferric chloride.



needles (m. p. 119—120°) slightly darker in shade than methylglyoxal-phenylosazone, gives a deep red coloration with strong sulphuric acid.

The author is led to publish this preliminary note now, as owing to a loss through fire of notes and products, some months must elapse before the results of the oxidation experiments can be published in detail.

161. "A series of substituted nitrogen chlorides. Part II. The trichloro-phenyl-acyl-nitrogen chlorides." By F. D. Chattaway and K. J. P. Orton.

This paper is a continuation and completion of the authors' previous work on the substituted nitrogen chlorides which are directly obtainable from formanilide, acetanilide, and benzanilide.

It is shown that in anilides the formation of a nitrogen chloride or bromide in all cases precedes substitution in the nucleus and that the degree of difficulty with which the transformation of these nitrogen chlorides and bromides can be effected corresponds with the relative difficulty of obtaining the transformation products directly by the action of the halogen.

The following compounds are described.

2:4:6-*Trichloro-phenyl-formyl nitrogen chloride*, $\text{C}_6\text{H}_2\text{Cl}_3 \cdot \text{NCl} \cdot \text{CHO}$, brilliant white prisms terminated by domes, m. p. 78°; 2:4:6-*Trichloro-phenyl-acetyl nitrogen chloride*, $\text{C}_6\text{H}_2\text{Cl}_3 \cdot \text{NCl} \cdot \text{COCH}_3$, white, transparent, prismatic crystals resembling cubes, m. p. 74°; 2:4:6-*trichloro-phenyl-benzoyl nitrogen chloride*, $\text{C}_6\text{H}_2\text{Cl}_3 \cdot \text{NCl} \cdot \text{COC}_6\text{H}_5$, thick white prisms terminated by pyramids, m. p. 89°; *p-chloro-phenyl-benzoyl nitrogen chloride*, $\text{C}_6\text{H}_4\text{Cl} \cdot \text{NCl} \cdot \text{COC}_6\text{H}_5$, glistening short white prisms with domed ends, m. p. 79·5°.

These compounds all show the general reactions characteristic of the nitrogen halogen linkage.

162. "The reaction between cupric sulphate solution and magnesium, zinc, and iron." By R. M. Caven, B.Sc., F.I.C.

When magnesium, zinc, or iron reacts with cupric sulphate solution, the usual assumption of simple replacement of metal by metal is in

no case found to be exactly true; cuprous oxide invariably occurs to a greater or less extent together with metallic copper in the residue.

The suggestion of Divers (*Proc.*, 1898, 14, 57) that the cuprous oxide formed in the reaction with magnesium is due to the production of cuprous sulphate, is well in accord with the facts established; but the separation of cuprous oxide is not connected with the formation of the basic cupric sulphate produced by hydrolysis, as suggested by Divers, since it is produced in considerable quantity, together with an equivalent amount of sulphuric acid, in hot strong solutions, in which spontaneous hydrolysis of cupric sulphate with separation of insoluble basic salt does not occur. That the cuprous oxide is produced by the hydrolysis of cuprous sulphate is borne out by all the facts; and this view is supported by the observations of F. Foerster (*Zeit. Elektrochemie*, 1897, 3, 479, 493).

In all the reactions examined, with the exception of that of iron reacting with cold solutions, hydrogen is evolved, though sometimes in small quantity only. J. B. Senderens states that hydrogen is evolved in this case also (*Bull. Soc. Chim.*, 1897, [iii], 17, 271), though his statement is not confirmed by the experiments of the author.

In those cases in which only copper and cuprous oxide appeared in the residue, the hydrogen evolved was calculated from the deficiency of the acid remaining in the solution from the quantity equivalent to the cuprous oxide found. This agreed with actual measurement; and also the sum of the equivalents of the copper, cuprous oxide, and hydrogen thus calculated, was equal to the quantity of the displacing metal employed.

The evolution of hydrogen in each case is due to one or more of the following distinct causes:

I. Reaction of displacing metal with sulphuric acid produced

(a) By hydrolysis of cupric sulphate, resulting in separation of insoluble basic cupric salt (Divers).

(b) By hydrolysis of cuprous sulphate, resulting in separation of cuprous oxide.

II. Action of the metallic couple upon the water of the solution.

III. Very slight reaction of finely-divided precipitated copper, with hot, dilute sulphuric acid, produced according to I (b).

In all cases except that of magnesium reacting with dilute solution, in which case the permanent separation of basic compounds takes place, the evolution of hydrogen may be eventually referred to the acid produced by hydrolysis of cuprous sulphate only.

The production of cuprous oxide and sulphuric acid in appreciable amount and in equivalent quantities, when cupric sulphate solution is brought into contact with finely-divided copper under various conditions, shows that cuprous sulphate is produced synthetically in the

above reactions. It is, however, believed that in most cases cuprous sulphate is also formed by the reduction of cupric sulphate by the replacing metal.

ADDITIONS TO THE LIBRARY.

Donations.

- Landolt, H. Optical activity and chemical composition. Translated by John McCrae. London 1899. From the Publishers.
- Walker, James. Introduction to physical chemistry. London 1899. From the Author.
- Lehfeldt, R. A. A text-book of physical chemistry. London 1899. From the Publishers.
- Collins, S. H. Handbook of agricultural chemistry for Indian students. Calcutta 1898. From the Author.
- Cooper, A. J. Elementary practical chemistry. London 1899. From the Publishers.
- Schuyten, M. C. Beginselen der scheikunde. Antwerpen 1899. From the Author.
- Roscoe, Sir Henry, and Harden, Arthur. Inorganic chemistry for advanced students: ill. London 1899. From the Authors.

At the next meeting, on Thursday, December 21st, the following papers will be communicated:—

“The condensation of glycollic aldehyde and formation of α - and β -acrose.” By Henry Jackson, B.A.

“On brasilin and hæmatoxylin. Part III.” By A. W. Gilbody and W. H. Perkin, jun.

“The action of alcoholic potash on monobromoglutaric ester.” By N. E. Bowtell and W. H. Perkin, jun.

“Mercurous iodide.” By P. C. Rây, D.Sc.

“On the interaction of mercurous nitrite and ethyl iodide.” By P. C. Rây, D.Sc.

PROCEEDINGS
OF THE
CHEMICAL SOCIETY.
EDITED BY THE SECRETARIES.

Vol. 15.

No. 216.

December 21st, 1899. Professor Thorpe, F.R.S., President, in the Chair.

Dr. Kohn was formally admitted a Fellow of the Society.

Certificates were read for the first time in favour of Messrs. Granville Reginald Gee, Falcon Villa, Howard Street, Gloucester; Alfred William Harvey, 13 Pendrell Road, St. Catherine's Park, Hatcham, S.E.; Thomas Ebenezer Mackenzie, 6 Cardonald Terrace, Cardonald, near Glasgow; William Mair, 388 Morningside Road, Edinburgh; John Livingston Rutgers Morgan, 47 Bayard Street, New Brunswick, New Jersey, U.S.A.; James Fraser Readman, 50 Jane Street, Glasgow; James McConnell Sanders, 37 Summerhill Road, Dartford; and of Sidney Calvert, Missouri State University, Columbia, Missouri, whose Certificate was approved by Council under Bye-law I (3).

The SECRETARY read the following letter, written by the President at the request of the Council, to Professor Emil Fischer, a Foreign Member of the Society, congratulating him on the completion of the twenty-fifth year of his Doctorate, together with a translation of Professor Fischer's reply.

16th November, 1899.

MY DEAR COLLEAGUE,

As President of the Chemical Society, I have the pleasure to offer you, by request of the Council, the warmest congratulations of the Fellows on the completion of the twenty-fifth year of your Doctorate.

It is not often that so short a span of intellectual activity in the life of any one individual comprehends such a brilliant series of scientific triumphs as those with which you have enriched chemistry.

That you may long be spared to cultivate the many fields of fruitful inquiry you have so assiduously opened up is the fervent wish of this Society, which recalls with pride that it numbers you amongst the most distinguished of its Foreign Members.

I have the honour to be, with great respect,

My dear Colleague,

Your obedient humble Servant,

T. E. THORPE,
President.

To Professor Dr. EMIL FISCHER,
Berlin.

The following is the translation of Professor Fischer's reply :—

10, DOROTHEENSTRASSE,
BERLIN.

29th November, 1899.

HIGHLY ESTEEMED PRESIDENT,

I have been most agreeably surprised by the honour as well as the heartiness of the congratulations which you have conveyed to me in the name of the Chemical Society on the occasion of the celebration of the 25th year of my Doctorate. Your Society and other learned bodies in England have indeed done me so much honour that I am obliged to ask myself, with diffidence, whether it bears any relation to my achievements.

The time when the fundamental principles of our Science were laid down, and when it was possible for the individual investigator to stamp the impress of his own mind upon it, is long since past, and in the gigantic structure which it now represents, each fellow-worker can only finish some small fragment, or it may be, if he is fortunate, a pretty balcony or a striking turret. The progress of the whole, is however, most readily accomplished by the combined efforts of numerous gifted and skilled observers. This co-operation, so characteristic of the scientific work of the present day, is exhibited in its highest form by the great Chemical Societies, of which yours is the oldest and has served as a model for the others.

I am proud, therefore, to be allowed to belong to it as a Foreign Member, and I beg, esteemed President, that you will be so good as to

convey to your Council my heartfelt thanks for their kind congratulations.

With the highest esteem,

Yours obediently,

EMIL FISCHER.

PROF. DR. THORPE,

*President of the Chemical Society,
London.*

Of the following papers, those marked * were read.

- *163. "On the refractive and magnetic rotatory powers of some aromatic hydrocarbons, and on the refractive powers of mixtures." By W. H. Perkin, LL.D., F.R.S.

The first part of the paper deals with a comparison of the magnetic rotatory and refractive powers of aromatic hydrocarbons undertaken to see if these properties were analogous in character. Most of the hydrocarbons employed were of exceptional purity, many being prepared from the pure salts of their sulphonic acids. An account is given of the preparation and properties of *isobutylbenzene*, prepared by this method for the first time.

With regard to the refractive powers of these substances, the results obtained show that the replacement by methyl of a hydrogen atom in the nucleus gives a value considerably *larger* than when the replacement takes place outside, and this is so certainly up to four such replacements, and therefore probably for the six. The replacement of hydrogen outside the nucleus by methyl (as in the conversion of toluene into ethylbenzene) also gives results somewhat higher than those calculated, but these values tend to coincide more nearly as the distance from the nucleus increases.

With the magnetic rotations, the reverse was found to hold, as a considerably *smaller* increase in the rotation is produced by a change in composition of CH_2 in the nucleus, than when it occurs outside. This holds for four replacements, and therefore probably for all.

These results are remarkable when the general correspondence between the magnetic rotatory and refractive powers of compounds is considered.

The second part refers to the refractive powers of mixtures. It has been shown that in the case of the magnetic rotations of mixtures these are usually less than those calculated from the molecular rotations of the constituents when their specific rotations are widely apart, hence it was of interest to determine whether a similar differ-

ence existed in the case of the refractive powers of mixtures. It was found that when the two constituents had very widely differing indices of refraction the specific, or molecular refraction was considerably lower than that calculated, but that when indices were nearly the same, the calculated and observed values agreed very well. That this latter statement holds, was shown by means of a mixture (a) of fatty compounds, (b) of aromatic compounds. These differences were most marked in mixtures of two fatty compounds having indices widely apart; in mixtures of a fatty with an aromatic compound, they were less pronounced.

Many of Zecchini's experiments with mixtures give results of a similar character to those described above, but exceptions occur which seem to indicate that although the differences between the refractive powers of the substances employed appear to be the chief cause of these peculiar results, other causes must also be at work. A new and improved arrangement for reading the scale and vernier of the spectrometer was described and shown.

DISCUSSION.

The PRESIDENT, after recalling the fact that differences similar to those observed by the author had been also observed with regard to the viscosity of pure compounds and mixtures of them, inquired why mixtures in equal volumes rather than in molecular proportions had been employed in this investigation.

Dr. GLADSTONE remarked that the results of the author to a certain extent explained some of the difficulties met with by early workers in the field of molecular refraction, and that many of them had observed similar small differences which were yet quite beyond the limit of experimental error. There was no doubt that researches such as those of Dr. Perkin must tend to throw more and more light on the causes of these small divergences in the optical properties and hence to reveal more fully the structure of the molecule.

Dr. PERKIN, in reply, said that the use of mixtures of equal volumes of the constituents had originated in his work on magnetic rotation, as such mixtures allowed of more ready comparison of the indices of refraction, densities, &c., of the mixtures and their components.

*164. "Formation of α - and β -acrose from glycollic aldehyde." By Henry Jackson, B.A.

When a dilute (3 per cent.) aqueous solution of glycollic aldehyde is allowed to stand with a 1 per cent. solution of soda for 15 hours at 0°,

it is still able to reduce Fehling's solution in the cold (though not so strongly as a solution of glycollic aldehyde), and to restore the colour to an alcoholic solution of magenta which has been decolorised by sulphurous acid. If the condensation product be neutralised with acetic acid, then heated on the water-bath with phenylhydrazine acetate, an osazone is obtained which, on purification and fractional treatment with various solvents, can be shown to contain tetrosazone [obtained previously by Fischer and Landsteiner, (*Ber.*, 1892, 25, 2549), by condensing glycollic aldehyde with soda at 0°], and two hexosazones, α -acrosazone, m. p. 217°, and β -acrosazone, m. p. 158°.

If the condensation be allowed to proceed for a longer time at 0°, it is found that the power of reducing Fehling's solution in the cold gradually diminishes until, after standing 6 days, it no longer reduces in the cold, but quickly on warming. The osazone obtained consists almost entirely of a mixture of the two hexosazones (α - and β -acrosazone), only a trace of tetrosazone being found.

DISCUSSION.

Mr. FENTON said that it was evident, both from these and from previous observations, that the condensation products of glycollic aldehyde and of formaldehyde were identical. It was probable that glycollic aldehyde was an intermediate stage in the condensation of formaldehyde, especially as Pechmann (*Ber.*, 1897, 30, 2459) had shown that the osazone of glycollic aldehyde could be obtained directly from formaldehyde and phenylhydrazine in acetaldehyde solution.

165. "The interaction of mercurous nitrite and ethyl iodide." By P. C. Rây, D.Sc.

When mercurous nitrite acts upon ethyl iodide, about equal quantities of nitroethane and its isomeride, ethyl nitrite, are formed. The yield is, however, somewhat poorer than when silver nitrite is used, owing to the formation of very compact lumps of mercurous iodide, which prevents the reaction from becoming complete.

166. "On mercurous iodide." By P. C. Rây, D.Sc.

When the residue in the flask after the interaction of mercurous nitrite and ethyl iodide is heated in a tube, mercurous iodide sublimes off between 190° and 210°. The compact mass of crystalline tablets thus obtained shows all gradations of tint from lemon- and orange-yellow to dark brown.

167. "The action of alkyl iodides on the mercuric iodide sulphides of the fatty series." By Samuel Smiles, B.Sc.

The alkyl sulphides unite with mercuric iodide to form compounds of the general formula R_2SHgI_2 . Like other addition products of the sulphides, their constitution should be represented as $R > S < \begin{smallmatrix} HgI \\ I \end{smallmatrix}$.

The following members of the series were examined :

Me_2SHgI_2 , long, yellow needles from acetone, m. p. 75° .

$MeEtSHgI_2$, short prisms from acetone, m. p. 59° .

Et_2SHgI_2 , yellow prisms from acetone, m. p. 52° .

$(C_5H_{11})_2SHgI_2$ (isoamyl), yellow oil.

$(C_7H_7)_2SHgI_2$, pale yellow plates from acetone, m. p. $37-38^\circ$.

These substances are unstable, readily splitting off mercuric iodide when exposed for any length of time to the air, or when boiled with water. Dimethylsulphide mercuric iodide, when treated with methyl iodide, yields the same product as that obtained from trimethylsulphine iodide and mercuric iodide, namely, Me_3SIHgI_2 . The same holds good for the triethyl derivative. Hence the double salts formed from mercuric iodide and sulphine iodide appear to contain hexavalent sulphur, as their constitution may be represented as $R_3:S \ll \begin{smallmatrix} I_2 \\ HgI \end{smallmatrix}$.

Therefore, it was hoped that an investigation of the derivatives containing different alkyl groups would yield evidence as to the stereochemical nature of hexavalent sulphur. So far, however, only negative results have been obtained.

The following substances were prepared and examined :

Me_3SI_2HgI , large, yellow prisms from acetone, m. p. 165° .

From (1) Me_3SI and HgI_2 ; (2) Me_2SHgI_2 and MeI .

Me_2EtSI_2HgI , long, yellow prisms from acetone, m. p. 87° .

From (1) Me_2EtSI and HgI_2 ; (2) Me_2SHgI_2 and EtI ; (3) $MeEtSHgI_2$ and MeI .

$MeEt_2SI_2HgI$, bright yellow prisms from acetone, m. p. 67° .

From (1) Et_2MeSI and HgI_2 ; (2) Et_2SHgI_2 and MeI ; (3) $MeEtSHgI_2$ and EtI .

Et_3SIHgI_2 , bright yellow leaflets from acetone, m. p. 112° .

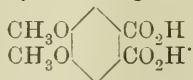
From (1) Et_3SI and HgI_2 ; (2) Et_2SHgI_2 and EtI .

Just as in the case of the nitrogen compounds such isomerism as might be expected here may be prevented by the presence of methyl or ethyl groups, it will therefore be necessary to repeat this with derivatives containing more complex radicles.

Attempts were also made to resolve methyl ethyl thetine, $MeEtS \ll \begin{smallmatrix} CH_2 \cdot CO \\ O \end{smallmatrix}$, into optically active components, but without success.

168. "On brasilin and hæmatoxylin. Part III." By A. W. Gilbody and W. H. Perkin, jun.

In a previous communication (*Proc.*, 1899, 15, 27), an acid obtained from brasilin was described which melted at 155° and gave, on analysis, numbers agreeing with the formula $C_{15}H_{16}O_6$. This acid, on oxidation with potassium permanganate, yielded a dibasic acid melting at $200-203^{\circ}$, which, when heated with hydrochloric acid at 160° , was decomposed with formation of catechol. Further investigation has shown that this acid, which at first was thought to have the formula $C_{10}H_{10}O_8(CO_2H)_2$, is in reality *metahemipinic acid*,



This has been conclusively proved by converting the acid into its anhydride and characteristic ethylimide (m. p. 230°). *Tetramethylhæmatoxylin*, when oxidised with chromic acid, also yields considerable quantities of *metahemipinic acid*, a proof that hæmatoxylin, like brasilin, is a derivative of catechol. As this result does not agree with the statement of R. Meyer (*Ber.*, 1879, 12, 1393) that hæmatoxylin, on distillation, yields pyrogallol and resorcinol, we have repeated this work, and find that the products of the destructive distillation of hæmatoxylin contain considerable quantities of pyrogallol, but, as far as we could determine, no trace of resorcinol.

It follows, therefore, from these experiments, that whereas brasilin is a derivative of resorcinol and catechol, hæmatoxylin is a derivative of pyrogallol and catechol.

The formation of metahemipinic acid from both brasilin and hæmatoxylin shows that the formulæ which we suggested for these substances require some modification. It would be easy to construct formulæ which would take these new facts into account, but we prefer to wait until further experimental evidence is forthcoming before doing so. We hope, therefore, that others working in this field will allow us to reserve for a short time the deduction of any formulæ for brasilin and hæmatoxylin which are based on the new results described in this and the two preceding preliminary communications.

It should be noticed that the melting point of tetramethylhæmatoxylone is incorrectly given as 170° in the previous communication, it should be $183-186^{\circ}$ with vigorous decomposition.

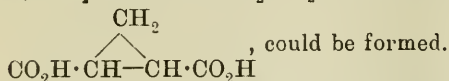
169. "The action of alcoholic potash on monobromoglutaric ester." By N. E. Bowtell and W. H. Perkin, jun.

A short time since (*Trans.*, 1899, 75, 50) it was shown by J. F. Thorpe and one of us that when *monobromodimethylglutaric ester*,

$\text{CO}_2\text{Et}\cdot\text{CHBr}\cdot\text{CMe}_2\cdot\text{CH}_2\cdot\text{CO}_2\text{Et}$, is digested with alcoholic potash, it yields a mixture of *cis*- and *trans*-dimethyltrimethylenedicarboxylic

acids (caronic acids), $\text{CO}_2\text{H}\cdot\text{CH}(\text{CMe}_2)\text{---CH}\cdot\text{CO}_2\text{H}$. It occurred to us that

it would be interesting to investigate the behaviour of *monobromoglutaric ester*, $\text{CO}_2\text{Et}\cdot\text{CHBr}\cdot\text{CH}_2\cdot\text{CH}_2\cdot\text{CO}_2\text{Et}$, under similar conditions, as in this case there are two possibilities, namely, either glutaconic acid, $\text{CO}_2\text{H}\cdot\text{CH}:\text{CH}\cdot\text{CH}_2\cdot\text{CO}_2\text{H}$, or trimethylenedicarboxylic acid,



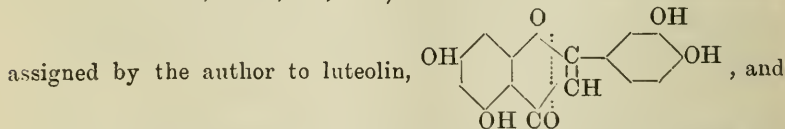
Monobromoglutaric ester was obtained as a colourless oil boiling at $165\text{--}170^\circ$ (35 mm.) by brominating glutaric anhydride and pouring the product into alcohol. When this ester is decomposed by alcoholic potash, an acid is obtained melting at 175° , which on examination was found to consist of *trans-trimethylenedicarboxylic acid*, and we were unable to isolate even traces of glutaconic acid.

This remarkable result points to the possibility that many substances produced by similar reactions and described as unsaturated may in reality be derivatives of trimethylene, tetramethylene, &c.

We are engaged in investigating the action of alcoholic potash on the esters of bromine substitution products of adipic, pimelic, and allied acids.

170. "Luteolin. III." By A. G. Perkin.

Previous investigations (*Trans.*, 1896, 69, 206, 799) indicated that luteolin, $\text{C}_{15}\text{H}_{10}\text{O}_6$, is a tetrahydroxyflavone. The energetic action of alkali yielded phloroglucinol and protocathechuic acid, confirming Rochleder's results (*Zeit. für Chem.*, 1866, 2, 602), and it is now found that, by gentler treatment, phloroglucinol and a substance having the composition $\text{C}_8\text{H}_8\text{O}_3$ are formed. ($\text{C} = 63.16$; $\text{H} = 5.26$. Found $\text{C} = 63.47$; $\text{H} = 5.61$). The substance (colourless needles, m. p. $115\text{--}116^\circ$) gives, with fused alkali, protocathechuic acid, and its properties are identical with those of *acetylcatechol*, $\text{CH}_3\cdot\text{CO}\cdot\text{C}_6\text{H}_3(\text{OH})_2$ (Dziedzowski, *Jour. Russ. Chem. Soc.*, 1893, 25, 157). This confirms the constitution



is identical in its nature with the decompositions of chrysin, $\text{C}_{15}\text{H}_{10}\text{O}_4$ (Kostanecki, *Ber.*, 1893, 26, 2901), and apigenin (*Trans.*, 1897, 71, 805), which respectively yield phloroglucinol and acetophenone, and phloroglucinol and *p*-hydroxyacetophenone.

In conjunction with Mr. L. H. Horsfall, an investigation is in progress upon certain ethers of luteolin. By partial methylation, a *dimethyl ether* (found C=65.06; H=4.55; $\text{CH}_3=9.92$), colourless needles, m. p. 227—229°, is formed in small quantity; this is almost devoid of dyeing property, and by means of alkali gives *isovanillic acid*. There is evidence that, in addition to luteolin, weld contains a trace of a second colouring matter.

171. "The action of chloroform and potassium hydroxide on orthoamidobenzoic acid." By Walter J. Elliott, M.A.

By acting on orthoamidobenzoic acid with chloroform and potassium hydroxide, acidifying the product with acetic acid, and treatment with phenylhydrazine and semicarbazide respectively, the author has obtained the phenylhydrazone and semicarbazone of an aldehydo-orthoamidobenzoic acid. Owing to its great solubility in water, he has failed to obtain the free aldehydo-acid in a state of purity. The barium and silver salts of the phenylhydrazone have been prepared and analysed. The hydrazone and semicarbazone are both very stable.

172. "Azo- and hydrazone compounds differentiated by bromine." By H. E. Armstrong.

Although the constitution of the "oxyazo"-compounds has been the subject of numerous investigations, apparently chemists are not yet in agreement as to their formulæ; indeed, only recently, Hantzsch in Germany, and MacPherson in America, have arrived at diametrically opposite conclusions. The difficulty arises from the fact that para-hydroxyazobenzene—the parent of all "oxyazo"-compounds—and quinoxalene are unquestionably isodynamic. Methods such as Hantzsch and Farmer have adopted must, therefore, be regarded as in principle the only suitable ones for the determination of structure in such cases, and extreme care must be taken in interpreting interactions.

A number of observations made in the author's laboratory by Messrs. Panisset, Seligmann, and Isherwood are of interest as bearing on the problem.

The stability of diazobenzene in presence of bromine was established by Griess in his earliest investigation. Diazobenzeneparasulphonate is also untouched by bromine, and action only takes place gradually as it becomes hydrolysed. Azobenzene is only very slowly and imperfectly acted on by bromine. Nitrogen, in fact, by no means tends to promote substitution, unless associated with hydrogen.

If oxyazobenzene were parahydroxyazobenzene, one would expect it to be readily brominated in the ortho-position relatively to the hydroxyl; but, as a matter of fact, it yields a product convertible into parabromaniline and phenol on reduction, and which is easily prepared from these, a result only compatible with the view that towards bromine it behaves as a hydrazone.

This view is confirmed by the fact that when the ethylated compound is brominated, a substance is formed which Mr. Isherwood finds to be identical with that produced on coupling orthobromophenol with diazobenzene and then ethylating. It is noteworthy that the bromine is removed from this compound with exceptional facility, both when dissolved in acetone, and when left in contact with sulphurous acid.

The behaviour of bromine in excess towards the quinhydrazones is characteristic. Quinonebromophenylhydrazone is resolved by it into bromodiazobenzene and tribromophenol, and ordinary tropæolin into diazobenzenesulphonate and tribromophenol. So complete is the change in this latter case, that if, after the tribromophenol has been filtered off, phenol be added to the solution, and then alkali, an amount of tropæolin can be recovered almost equal to that originally taken.

ADDITIONS TO THE LIBRARY.

I. Donations.

Baskerville, Charles. School Chemistry. Richmond, Va., 1899.

From the Author.

Gowland, William. The early metallurgy of copper, tin, and iron in Europe, as illustrated by ancient remains, and the primitive processes surviving in Japan. (Read before the Society of Antiquaries, May, 1899).

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Richmond, H. Droop, Dairy chemistry: a practical handbook for dairy chemists and others having control of dairies: ill. London 1892.

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II. By Purchase.

Bosqui, Francis L. Practical notes on the cyanide process: ill. New York 1899.

Van't Hoff, J. H. Vorlesungen über theoretische und physikal-

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Jessen-Hansen, H. Sur le dosage du sucre interverti à côté du sucre de canne. (*Compte-Rendu des Travaux du Laboratoire de Carlsberg*, vol. iv., 1899.)

Jowett, H. A. D. The characters and methods of assay of the official hypophosphites, and a note on the hydriatic alkaloids. (*Pharmaceutical Journal*, 1898.)

——. The assay of preparations containing pilocarpine and the characters of pilocarpine nitrate and hydrochloride. (*Pharmaceutical Journal*, 1899.)

Schryver, S. B. A new method for the analysis of commercial phenols. (*Journal of the Society of Chemical Industry*, vol. xviii., 1899.)

——. Preparation of acid phenylic salts of dibasic acids. London 1899.

Snell, J. F. Potassium chloride in aqueous acetone. (*Journal of Physical Chemistry*, vol. ii., 1898.)

Spring, W. Sur la diffusion de la lumière par les solutions.

——. Sur la réalisation d'un liquide optiquement vide. (*Bull. de l'Acad. roy. de Belgique, classe des Sciences*, 1899.)

VICTOR MEYER MEMORIAL LECTURE.

The Victor Meyer Memorial Lecture will be delivered by Professor T. E. Thorpe, President of the Society, on the evening of Thursday, February 8th, 1900, at 8.30.

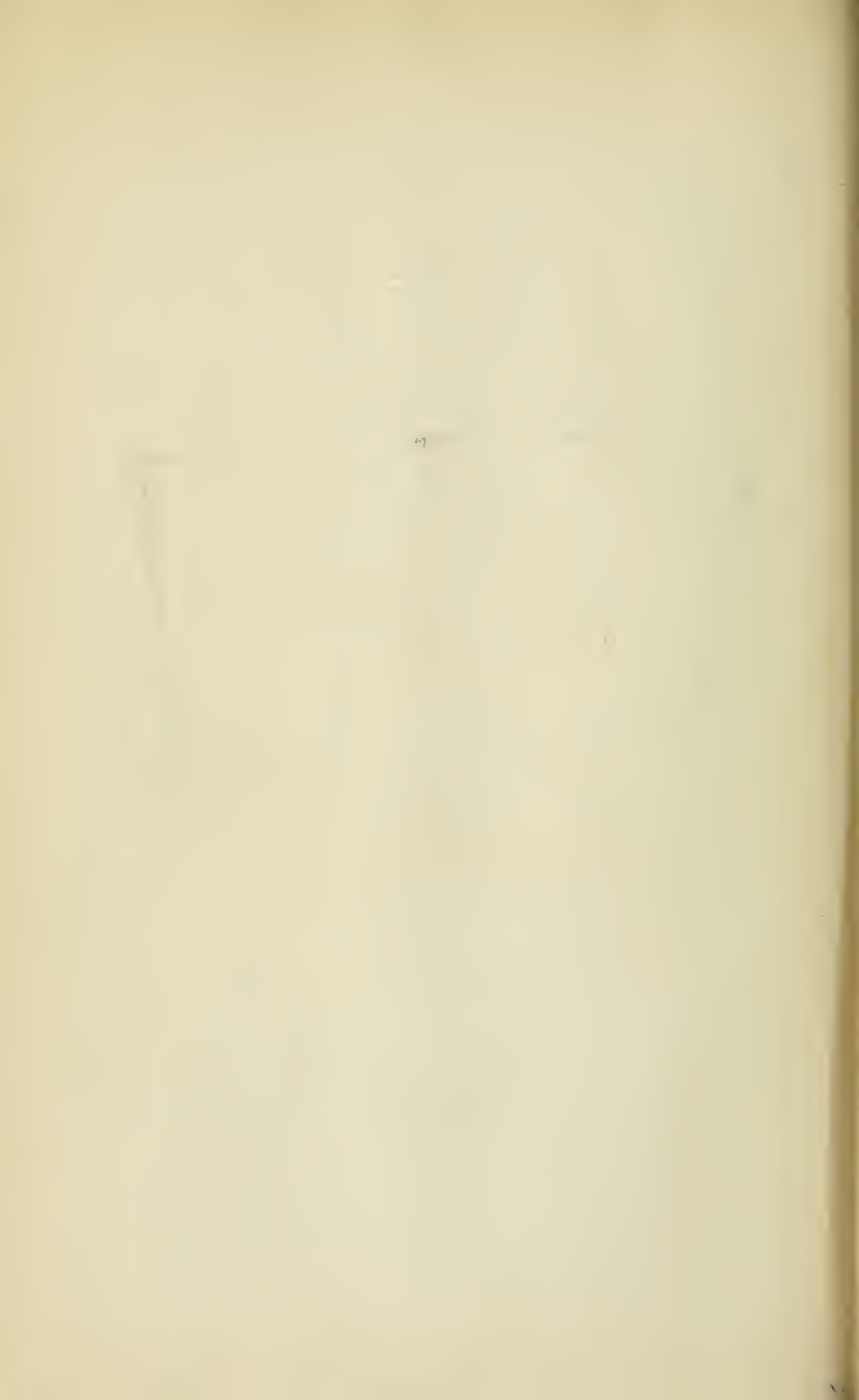
At the next meeting, on Thursday, January 18th, 1900, the following papers will be communicated:—

“Nitrogen halogen compounds.” By Julius Steiglitz and E. E. Slosson.

“Chlorine derivatives of pyridine. Part V. Synthesis of $\alpha\alpha'$ -dichloropyridine. Constitution of citrazinic acid.” By W. J. Sell, M.A., F.I.C., and F. W. Dootson, M.A.







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